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Business Innovation in Complex Ecosystems

A case from the construction industry

Master's thesis in Management and Economics of Innovation

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2023
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Report No. E2023:073

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Abstract

The existing body of literature on the business innovation process for established firms and the theories and methodologies for successful startup development is vast and extensively documented. However, the literature is not entirely adapted for smaller firms striving to develop their business. This thesis aims to bridge this gap by providing guiding principles that complement existing theories. To achieve this aim, a project in this setting was conducted where existing theories were applied, followed by a thorough analysis of the project itself to identify such guidelines. Furthermore, the project was undertaken in collaboration with Pålanalys AB with the objective to develop the business model for their product, Propile. Propile is a digital tool created for foundation firms allowing users to document, visualize and track their working progress. The conducted project involved a value creation assessment, new feature discovery, exploration of new markets abroad, and recommended next steps. While the existing theory proved effective in this context, five guiding principles were identified. Firstly, firms must have a profound understanding of their value creation process before pursuing business innovation. Secondly, external actors in new settings should possess both general and in-depth industry knowledge to be able to develop the business model. Thirdly, innovators hold the key to perceiving the broader vision by combining insights as puzzle pieces. Fourthly, firms with limited resources need to prioritize initiatives to avoid unfinished endeavors. Lastly, introducing entrepreneurial methods to firms requires addressing concerns and facilitating the adoption of new working approaches.

Keywords: business innovation, ecosystem, startup, foundation industry, construction industry.

Acknowledgements

I would like to acknowledge and express my gratitude to the following individuals and organizations for their contributions and support throughout the completion of this master's thesis.

First and foremost, I would like to express my sincere appreciation to my supervisor and examiner, Henrik Berglund, from the Department of Technology Management and Economics at Chalmers University of Technology. Throughout the process of conducting this master's thesis, his invaluable knowledge, guidance, and positive approach have been instrumental in navigating the challenges and ensuring the successful completion of this thesis.

Second, I am grateful to Mattias Grävare and Thomas Bjerendal, the owners of Pålanalys AB, for their unwavering support and commitment throughout the project. Their insights and continuous encouragement greatly contributed to this undertaking.

Third, I would also like to extend my gratitude to Fredrik Borg for his presence, interest, and input throughout the project. His role as a sounding board proved valuable in shaping and refining the project.

Fourth, I extend my sincere thanks to the opponents who provided concrete and comprehensive feedback. Your valuable insights and suggestions played a pivotal role in refining this master's thesis to its final form.

Lastly, I am grateful to all the interviewees who generously shared their time, insights, and experiences. Your commitment, interest, and integrity were fundamental in enriching this research. Without your invaluable contributions, this thesis would not have been possible.

Alexander Frykler, Gothenburg, June 2023

Contents

List of Figures

List of Tables

1
Introduction

This chapter outlines the thesis background and the aim and research approach.

1.1 Background

Undoubtedly, the success of innovation cannot solely rely on the development of a promising product or service, as various external factors can significantly impact its outcome. In his book *The Wide Lens*, Adner (2013) highlights the importance of considering the broader context in which an innovation is being introduced. For instance, the author refers to the first chapter titled *Why things go wrong when you do everything right*, where he emphasizes the interdependency of various actors in the innovation ecosystem. To illustrate this, Adner (2013) cites the example of Michelin, which successfully developed a flat-run tire after identifying a market demand. However, due to the lack of adoption by car workshops, the project eventually failed. Another example is Kodak, who successfully transformed from analog to digital technology but failed to recognize that the value architecture had shifted, rendering their offer obsolete (Adner, 2021).

From a business model innovation (BMI) perspective, Berglund and Sandström (2013) advocates similarly that BMI is affected by conditions outside the firm's boundaries using an open system perspective where firms act under restricted freedom. The business model can be defined as a broad overview of how a company or part of a company generates, delivers, and captures value, it focuses on a specific company, but it also extends beyond its borders (Berglund and Sandström, 2013). Furthermore, Berglund and Sandström (2013) proposes that first, whether a BMI is successful *will become more unpredictable when more actors are involved* and second, *A high degree of interdependence between the focal firm and the other actors involved will result in lower probability of successful BMI.* In other words, an ecosystem of many actors that are interdependent on each other is a complicated setting to successfully transform or develop a business model.

For startups with limited resources, effective distribution of resources is more critical for successful business development,particularly when operating within a complex ecosystem. A considerable amount of literature has been established covering how to focus as a start-up to proceed successfully. For instance, Blank (2013) proposes the use of the *Business Model Canvas*, customer discovery, and hypothesis-driven entrepreneurship, as a faster and more efficient approach compared to traditional business plans. Additionally, some articles, such as the work of Sarasvathy (2008), suggest that the entrepreneurial mindset should focus on effectual reasoning instead of causal reasoning, the former prioritizing the possibilities at hand while the latter concentrates on a predetermined goal. To summarize, these articles are designed to support practical business development while Adner (2013); Adner (2021); Berglund and Sandström (2013) are more focused on an aggregated level adapted for established firms.

While the existing body of literature provides comprehensive coverage of their respective domains it lacks guidance on how to integrate these disparate elements in a complex ecosystem to foster business growth for smaller established firms. Put differently, business innovation in small firms exists in a conceptual gap between the existing theories and therefore lacks guidance to address its unique characteristics and implications.

This thesis is organized as follows: the remainder of this chapter will cover the aim and research approach. Chapter 2 will delve into the literature review that underpins this research. Chapter 3 will provide a detailed explanation of the methodology employed in this study. Chapter 4 will provide a brief overview of the piling industry and Propile. Chapter 5 will present the result, followed by an analysis and discussion in Chapter 6. Lastly, Chapter 7 will present the conclusion of the study.

1.2 Aim and research approach

The aim of this thesis is to bridge the gap for smaller firms between innovation strategy on an aggregated level and startup theory by: *establish guiding principles for smaller firms that strive to develop their business within a complex ecosystem, including scenarios involving the participation of external actors without prior industry knowledge.*

To achieve this aim, it is imperative to conduct an in-depth exploration of the process involved in the development of such guidelines, involving and adapting existing frameworks. This will be conducted by undertaking a business innovation project in collaboration with Pålanalys AB. The project will involve the exploration and development of their software service, Propile. Propile is a cloud-based tool utilized for documenting piling construction progress. The project intends to investigate how the service could be developed to enhance its value proposition, as well as explore possibilities for entering new geographical markets. Furthermore, the project will serve as the foundation for the creation of guiding principles through a comprehensive analysis.

2

Literature Review

This chapter provides an overview of the key theories employed in this thesis. First, it presents the concepts of ecosystem theory and mapping. Secondly, startup methodologies are outlined.

2.1 Ecosystem theory and mapping

The following section first presents an overview of ecosystem theory. Second, it outlines a practical framework, which involves mapping the ecosystem.

2.1.1 Ecosystem theory

Depending on the scope of the analysis, the definition of an ecosystem varies. Jacobides et al. (2018) categorizes previous research into three categories: *platform ecosystem*, *innovation ecosystem* and *business ecosystem*. From the perspective of a platform ecosystem, a central platform is surrounded by various actors, and the emphasis lies on how these actors contribute with complementary innovation but also can have access to the platform's customers (Jacobides et al., 2018). Furthermore, the innovation ecosystem perspective focuses on the *alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize* (Sjödin et al., 2022).

The perspective of *business ecosystem* (hereafter ecosystem) is according to Jacobides et al. (2018) an individual organization that interacts and is interdependent with other entities to create value. Given the scope of this thesis, this is the perspective that will be used. Similar to Jacobides et al. (2018) is Adner (2021) defining an ecosystem as *the structure through which partners interact to deliver a value proposition to the end consumer*. This implies a departure from a simple linear value chain, where entity A only interacts with B, who only interacts with C, and so forth. Instead, ecosystems consist of dynamic collaborations where entities can interact with multiple different actors (Adner, 2013).

Moreover, in order to define an outer bound, generic complementarities do not belong to an ecosystem. Jacobides et al. (2018) illustrates this by highlighting that while electricity is utilized by almost everyone, it is not something that individuals are specifically dependent on a particular actor for, thus not significantly affecting ecosystem dynamics. Figure 2.1 created by Jacobides et al. (2018) illustrates the difference between an ecosystem and other types of value systems.

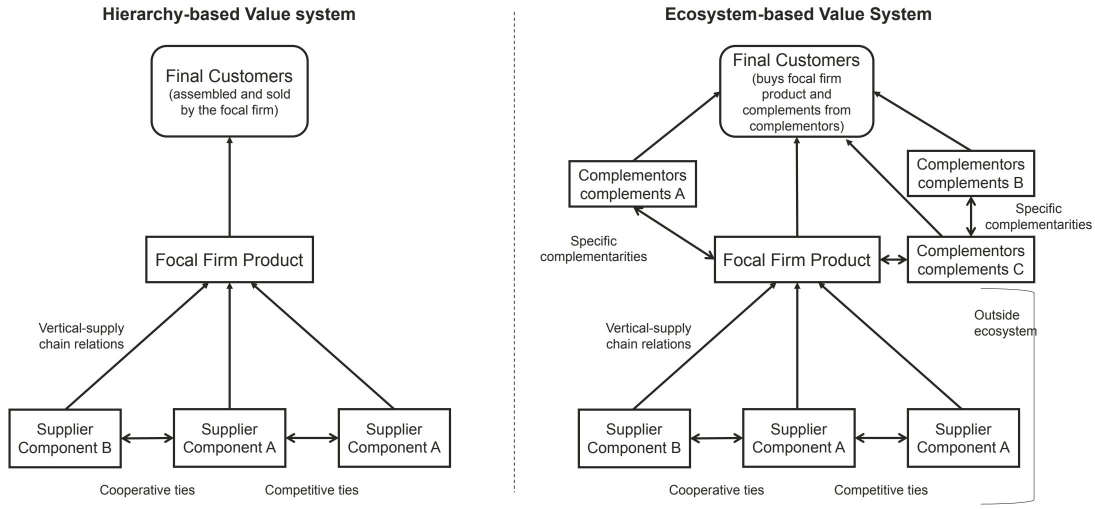

Figure 2.1: Comparison of different value systems (Jacobides et al., 2018).

Furthermore, ecosystems are not seen as a static configuration, rather there are forces changing the dynamics (Dattée et al., 2017). Holgersson et al. (2022) divides these forces into two categories, *Technological Complementarities* and *Management and Coordination*. Technological complementarities pertain to the dynamic nature of the complementarities themselves. For instance, new innovations can render a once unique complementarity generic, resulting in the corresponding actor no longer being a part of the ecosystem (Holgersson et al., 2022). On the other hand, management and coordination encompass the influence of governance, firm boundaries, and alliances on the structure of the ecosystem (Holgersson et al., 2022). These factors shape the overall setup of the ecosystem, influencing how actors interact and collaborate within it.

2.1.2 Mapping the ecosystem

This subsection first presents an outline for mapping an ecosystem based on the framework proposed by Adner (2013). Subsequently, it provides a detailed description of the adoption chain and co-innovation risk, which are integral components of this framework.

Adner (2013) recommends ecosystem mapping for several reasons. First, it establishes a collaborative foundation, enabling both internal and external actors to share a common perspective. Second, it outlines interdependencies among actors. Lastly, it facilitates the assessment of the adoption chain and co-innovation risk. To construct what Adner (2013) refers to as *Value Blueprint*, the following 8 steps are involved:

1. Identify the end-user, the actor targeted by the value proposition.

2. Identify your own contribution and the required deliverables.
3. Identify suppliers associated with your part.
4. Identify intermediaries involved.
5. Identify complementarities.
6. Assess the risk associated with each actor. This includes the evaluation of adoption and co-innovation risk, which are described in more detail in the subsequent subsections.
7. Analyze the challenges and propose potential solutions to mitigate risks.
8. Continuously update the map as conditions and actors change.

Figure 2.2 provides an example of the outcomes achieved by following these eight steps.

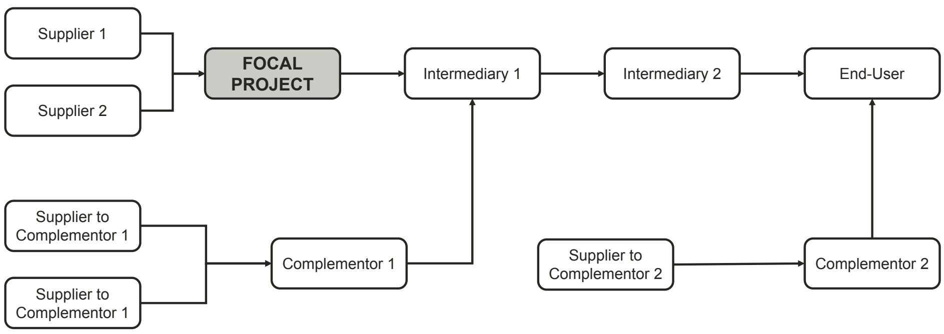

Figure 2.2: Ecosystem mapping example (Adner, 2013).

2.1.2.1 Co-innovation risk

Co-innovation can be viewed as a joint initiative involving multiple stakeholders, such as other firms or customers, to develop novel products or services (Saragih and Tan, 2018). In today's business landscape, many organizations engage in co-innovation to successfully bring new offerings to market by combining the resources and capabilities of different entities. However, numerous co-innovation initiatives encounter failure due to the dependency on the reliability of other firms' performance (Adner, 2013). Furthermore, while managers often employ established procedures to ensure the successful execution of their projects by addressing anticipated challenges, they frequently overlook the *blind spot of Co-innovation Risk* (Adner, 2013).

Nokia's journey toward 3G during the turn of the millennium serves as a compelling illustration of this blind spot. Adner (2013) describes how Nokia took into account its own development and the timely delivery of various components by its suppliers, resulting in Nokia pioneering the first-ever 3G mobile phone in 2000. However, in 2002, the sales of 3G devices amounted to only approximately 3 million, significantly lower than Nokia's estimate of 300 million (Adner, 2013). The primary reason for this disparity was that while component suppliers fulfilled their obligations, other actors within the ecosystem failed to do so. For example, broadcast companies struggled to convert video images from television or lacked functional digital rights management systems (Adner, 2013). Consequently, the 3G technology did not create significantly more value than the previous 2G technology. In other words, assessing the co-innovation risk within an established environment is comparatively less challenging than identifying and mapping out new actors in unfamiliar ecosystems.

To comprehend the significance of understanding Co-innovation risk, consider the following probability example. If the success of innovation hinges on the fulfillment of obligations by four actors, each with an 80% chance of meeting their commitments, the joint probability would be $0.8^4 = 0.41$ or 41%. It is however noteworthy as Adner (2013) emphasizes, a low probability of success does not necessarily imply that one should refrain from innovating. Rather, it underscores the importance of being aware of the likelihood of success and taking appropriate actions thereafter.

2.1.2.2 Adoption chain risk

Adoption chain risk refers to *the extent to which partners need to adopt your innovation before end consumers have a chance to assess the full value proposition* (Adner, 2013). In essence, it addresses the question of which actors within the ecosystem need to accept the new product or service to enable its reach to the end user. Furthermore, Adner (2013) argues that perceived total value (benefits - costs) from an external actor's perspective also includes changes such as training and equipment upgrades, aspects that innovators often overlook. The introduction already highlighted Michelin's example of the flat-run tire, which exemplifies this phenomenon.

Moreover, when assessing the adoption chain, the strength of the innovation is contingent on the weakest link in the chain. To illustrate, consider an adoption chain consisting of an innovator, distributor, retailer, and end customer. Regardless of the perceived total value for any of these actors, the innovation will fail if not all of them perceive it as a surplus (Adner, 2013). Lastly, the difference between adoption chain and co-innovation risk is that the former refers to the acceptance of a new product or service while the latter relates to the successful development of a specific component of the promised innovation by a partner.

2.2 Startup methodologies

This section will initially address the concept of ideation, which entails the process of uncovering new opportunities. Subsequently, it will explore the aspect of designing, which refer to the procedure of developing an opportunity into a viable product or service.

2.2.1 Ideation

This subsection provides a brief overview of the process involved in exploring novel ideas that can manifest as viable products or services. As highlighted by Blank and Dorf (2012), a crucial aspect of generating ideas for startups is to *get out of the building* as facts and insights are not readily discovered within the local office. Interacting with potential customers is paramount, as it enables one to determine whether ideas are mere invalid hypotheses or possess genuine potential.

Moreover, the process of ideation necessitates adopting a problem-centric approach rather than focusing solely on solutions. As Blank and Dorf (2012) asserts, successful products effectively address a problem or fulfill a specific need. Furthermore, Blank and Dorf (2012) describe diverse scenarios ranging from customers who are not aware of a problem's existence, those who are aware but lack knowledge of how to resolve it, individuals who acknowledge the issue but have yet to find a suitable solution, to those who possess a vision for resolving the problem but struggle with implementing the solution. Additionally, the importance assigned to a given problem can vary considerably (Blank and Dorf, 2012).

In the process of finding problems, Drucker (1998) suggests that one should analyze the following areas: (1) Unexpected (2) Incongruites (3) Process needs (4) Industry and market changes (5) Demographic changes (6) Changes in perception (7) New knowledge

Another approach to identifying problems, as described by Christensen, Anthony, et al. (2007), is to look on the job that needs to be done rather than solely on product functionality. According to Christensen, Anthony, et al. (2007), customers seek a product or service to hire to fulfill a specific task or job. Or as Levitt (1984) put it, customers *do not want a quarter-inch drill. They want a quarter-inch hole!* While this approach can be useful to identify opportunities, it may as well serve as an understanding of a customer segment as well as potential competitors (Christensen, Anthony, et al., 2007).

In summary, interactions with relevant stakeholders and the exploration of problems rather than immediate solutions are crucial where Drucker (1998) delineates seven distinct areas where problems can be found. Finally, considering the concept of jobs to be done can serve as a perspective for identifying opportunities and problems.

2.2.2 Designing

Designing can be seen as the next phase embarking from the ideation phase. According to Berglund, Bousfiha, et al. (2020), there are two distinct categories known as *ideal types of entrepreneurial design*, experimentation and transformation. Experimentation involves the utilization of artifacts to efficiently conduct experiments, with uncertainty being mitigated through information gathering. On the other hand, transformation utilizes artifacts to transform and facilitate interactions and overcome uncertainty through negotiation and co-creation (Berglund, Bousfiha, et al., 2020). In the subsequent subsections, the categories are outlined in a more practical setting.

2.2.2.1 Experimentation

The *lean start-up methodology* proposed by Ries (2011) falls mainly under the category of experimentation (Berglund, 2021). The purpose of this approach is to maximize learning and insights and minimize uncertainty per unit spend resource, ultimately striving to achieve *product-market-fit* (Eisenmann et al., 2012). To achieve efficiency, Ries (2011) suggests that startups should adopt a *build-measure-learn* methodology which should be iterated as quickly as possible. To facilitate such process a *minimum viable product* (MVP) is recommended, which is a product developed as quickly and simply as possible (Ries, 2011). This process should also involve active engagement with potential customers, or as Blank and Dorf (2012) state, *get out of the building*. Feedback gathered through this iterative process should guide decision-making, leading to either a pivot (altering the course) or perseverance on the same path (Ries, 2011).

In order to effectively execute this methodology, ideas, and visions should be translated into testable hypotheses that can be either verified or discarded (Eisenmann et al., 2012). To structure the process, the flowchart created by Eisenmann et al. (2012) in Figure 2.3 could be utilized.

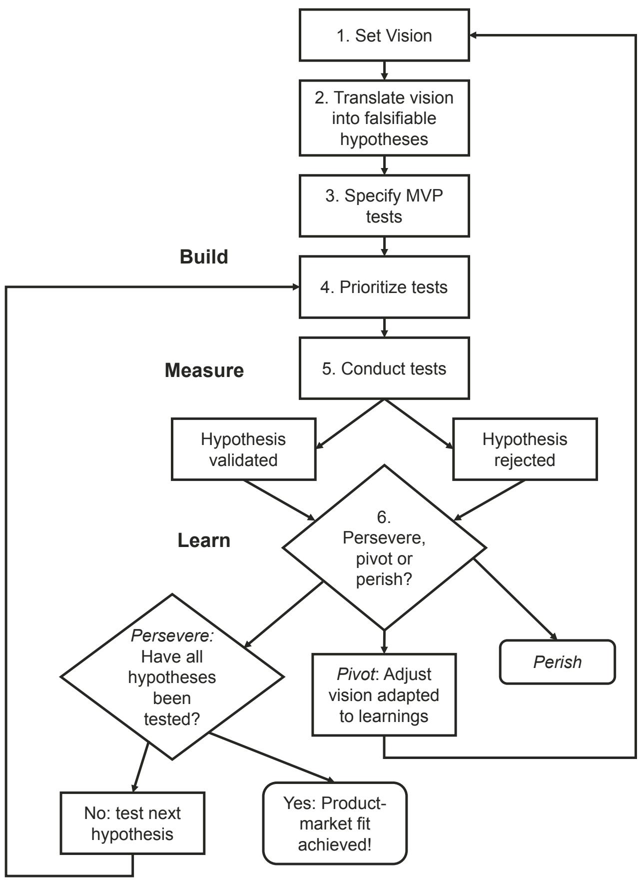

Figure 2.3: Hypotheses testing structure (Eisenmann et al., 2012).

2.2.2.2 Transformation

Sarasvathy's (2008) theory of effectuation can be considered as a component of the transformation category (Berglund, 2021). The concept of effectuation can be understood as the opposite of causal reasoning, emphasizing a different mindset or perspective (Sarasvathy, 2008). Instead of having a predefined goal, the focus is on a *given set of means*, letting the goal arise over time. A visual representation of this concept is depicted in Figure 2.4.

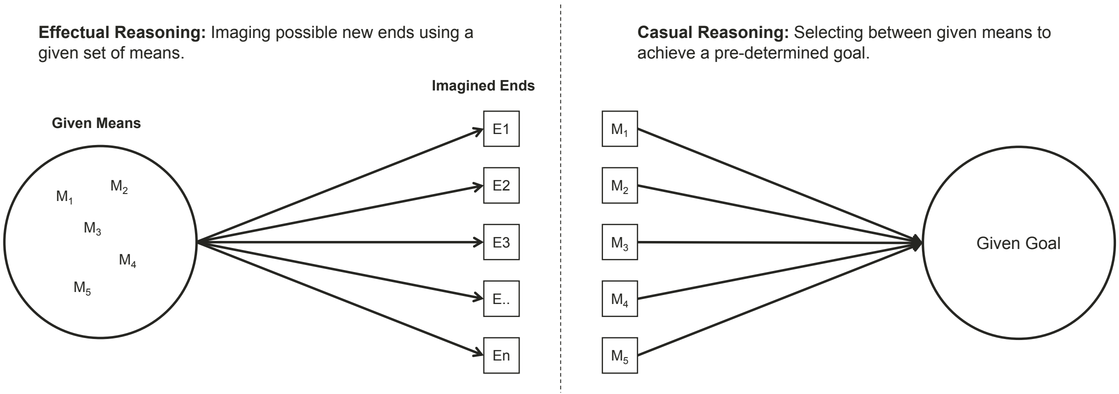

Figure 2.4: Comparison of effectual and causal reasoning (Sarasvathy, 2008).

Furthermore, Sarasvathy (2008) presents three principles of effectual reasoning. First, effectual reasoning prioritizes what one can afford to lose rather than expected returns. Second, it emphasizes the importance of strategic partnerships and collaboration, rather than analyzing the competitive landscape. Lastly, effectual reasoning revolves around *leveraging contingencies* instead of maximizing prior art (Sarasvathy, 2008).

3

Methodology

This chapter delineates the methodology implemented to address the aim of this thesis: establish guiding principles for smaller firms that strive to develop their business within a complex ecosystem, including scenarios involving the participation of external actors without prior industry knowledge. The methodology comprises five components: research strategy and design, empirical context and scope of the study, research procedures, research methods, and research quality.

3.1 Research strategy and design

To achieve the aim of providing guiding principles for small firms in a complex ecosystem, an action research methodology is adopted. The methodology involves collaborating with organization members to conduct experiments that aim to solve real-world problems (Bell et al., 2019). This iterative process entails problem identification, planning, action, and evaluation (Bell et al., 2019). The findings of such a study are expected to have both theoretical and practical significance, with implications that extend beyond the specific context of the case study (Bell et al., 2019). This approach is preferred for two reasons. First, it allows for an in-depth exploration of the research area, and second, to account for both the interest of the collaborator (firm) and the aim of academic contribution.

Moreover, the research design is leaning toward a case study design. A case study implies commonly a study of a specific workplace or organization (Bell et al., 2019). This design method is also chosen to facilitate an in-depth understanding of the research area, as compared to a more superficial treatment of many cases. Additionally, given the time constraints of this thesis, it would not be feasible to undertake a thorough exploration of multiple business cases. Finally, it is worth noting that while this study originates from a single organization, data will also be collected from external sources to inform how the firm can proceed. Therefore, this study does not solely constitute a cultivated case study.

Furthermore, the study is predominantly qualitative in nature, given its primary objective of evaluating the current situation and potential for the expansion of one product in a firm and creating guidelines from the outcome. Moreover, qualitative research tends to be of inductive character, however, inductive research approaches often contain deductive elements, and vice versa (Bell et al., 2019). This is also the case for this study by using existing literature as a foundation but applying them in a combined setting to develop guiding principles.

3.2 Empirical context and scope of the study

This project has been commissioned by Pålanalys, a Gothenburg-based construction consulting firm that specializes in the inspection of piling constructions. Pålanalys consists of four full-time employees and has an annual turnover of approximately MSEK 10 (Allabolag.se, 2023) and are solely active in the business-to-business sector. Piling is a widely used method to ensure that constructions such as buildings, highways, pathways, and bridges are protected from settling, shifting, or collapsing. The process involves driving, drilling, or casting piles into the ground to carry the load from the superstructure to competent geological strata. Piles are today most commonly constructed by concrete or steel and can be driven down over 100 meters in complicated geological regions. The inspection of piles is a legal requirement in Sweden and Pålanalys is contracted by several major foundation contractors to perform such inspections. Pålanalys has also created a digital service, Propile, as a secondary focus. Propile was initially intended to provide piling contractors with a digital documentation tool to replace traditional pen-and-paper methods. Over the course of 20 years, the service has evolved to include additional functionalities, such as project visualization, support for official follow-up, and cost control.

Pålanalys considers the potential of reaching new customers with Propile within Sweden to be limited due to market saturation. As a result, the company intends to explore the possibility of expanding the service to foreign markets. This may involve adapting the service to accommodate industries with different value chains, stakeholders, and potentially different piling techniques. Another potential expansion that Pålanalys considers is to investigate the possibilities of adding functionalities to the service and hence, extending the service's value proposition.

Although the employees of Pålanalys have vast knowledge about the piling industry due to their long-standing presence in the business and close relationships with their customers, the understanding of Propile, and its associated business model is lacking. Specifically, they are uncertain how it creates value, and which stakeholders within the customer organization are utilizing the service most effectively. Being customer-oriented, as emphasized by Lervik Olsen et al. (2014), particularly for firms offering services is crucial and it is not captured currently by Pålanalys. Customer orientation requires the systematic collection and measurement of customer data, which can then be used to inform and improve the service offering. While Pålanalys has relied on customer feedback to guide their previous development efforts, the collection of this data has been unstructured and spontaneous, which may result in the reliance on incomplete information when making important decisions. Thus, it is imperative to conduct a thorough investigation into how the service creates value for its customers before any considerations for expansion are explored.

Furthermore, the construction industry is a highly intricate ecosystem with various stakeholders involved. Alongside rig operators (who install the piles), this ecosystem also involves other contractors, supervisors, site managers, surveyors, geotechnical engineers, designers, excavators, clients, and consultants with specialized expertise. These stakeholders often work in parallel, and there is no standardized process for their interactions. Instead, the specific project conditions dictate the necessary procedures. Consequently, the complexity of this ecosystem demands a higher level of requirements for services to cater to the diverse needs of the various stakeholders.

3.3 Research procedures

In order to achieve the aim and adhere to the designated research design and strategy, the research protocol followed the procedures outlined in Figure 3.1. The grey-shaded area involves activities in collaboration with Pålanalys.

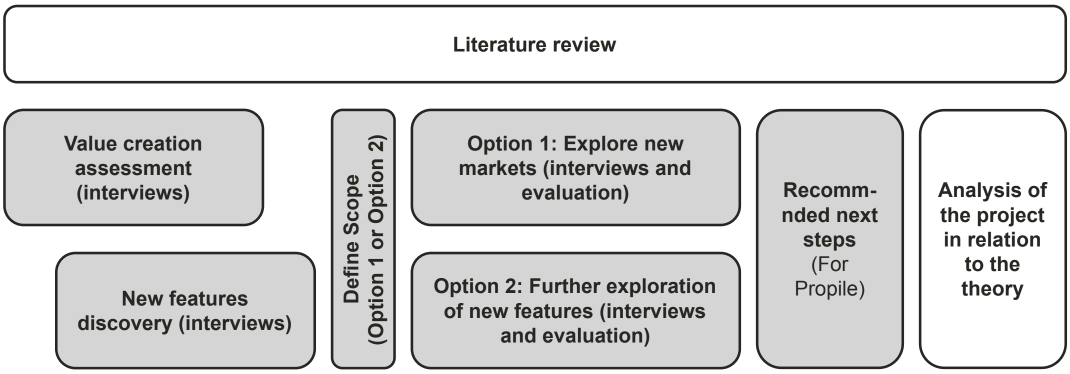

Figure 3.1: Sequence of research activities.

The initial phase involved conducting a comprehensive literature review to identify potentially relevant frameworks. As the case company's current situation became clearer, the literature review was refined and adapted to the current setting. In parallel, a first round of interviews was conducted to gain insights into the industry dynamics and how Propile currently adds value. This established a baseline for the research. As the study delves deeper into the service and industry, interviews also aimed to explore potential new features.

Based on the results of the interviews and the preferences of Pålanalys stakeholders, the intention was to define the scope of the project, focusing either on option 1: exploring how the service can be introduced in other countries, or option 2: developing new functionalities for existing customers. However, a decision was made to address both options instead. The underlying motivation for this course of action is outlined in greater detail in the result chapter. Furthermore, at the project's end, recommended next steps for Propile were outlined. Finally, an analysis of the project was conducted based on the insights and data generated during the project to identify guiding principles.

3.4 Research methods

The following section will first describe how data was collected and second, how the data analysis was conducted.

3.4.1 Data collection

Empirical data collection for this report has mainly been collected from interviews with persons working in the construction industry. The reason for this is first, to get an interpretive perspective and second, to follow Steve Blank's mantra of *getting out of the building* (Blank and Euchner, 2018). The structure, design, and sampling of the interviews will be described in the following subsections. In total, 24 interviews have been held were the majority of the interviews were held individually. The length of interviews lasted between 30-90 minutes depending on the available time of the interviewee and how much insight and interest they had in the topic.

The participants in the interviews primarily consist of established connections to Pålanalys, including current users of Propile and buyers of their pile inspection service. Additionally, a small number of participants were identified through snowball sampling. The type of role and company of the interviewees are presented in Table 3.1.

Furthermore, it should be noted that insights from stakeholders of Pålanalys are also included in the data collection process. However, these insights are not presented in Table 3.1; instead, they are explicitly referenced and discussed throughout the report. In addition to interviews, the report also incorporates information from annual reports of foundation firms. While these sources are acknowledged when used, the specific sources cannot be disclosed to ensure the confidentiality of the interviewee's workplace.

Table 3.1: Interviewee description: The numbering in the last column refers to the following: 1 refers to interviews with a focus on *industry and value creation*, 2 refers to *new functionalities discovery*, lastly, 3 refers to *enter foreign markets*. Multiple interviews with the same interviewee is denoted * while group interview are denoted **.

Sweden

Company	Interviewee's position	Interview purpose
Foundation Company A	Site Manager α*	1,2
Foundation Company B	Supervisor*	1,2
Foundation Company B	Project manager	1,2
Foundation Company A	Business developer	2
Foundation Company A	Project manager	2
Foundation Company A	Pile Factory Manager	1,2
Foundation Company A	Site Manager β	1,2
Foundation Company A	Skilled Worker	1,2
Foundation Company B	Skilled Worker	1
Foundation Company C	Skilled Worker	1
Consultant Company A	Construction Consultant	1,2
Civil Engineering Company A	Site Manager	1,2
Civil Engineering Company B	Surveyor	1,2
Consultant Company B	Geotechnical engineer	1,2
Civil Engineering Company A	Senior Surveyor	1,2
Consultant Company C	Geotechnical engineer	1,2
Civil Engineering Company C	CxO	2,3

Norway

Company	Interviewee's position	Interview purpose
Civil Engineering Company	Contract manager	3
Foundation Company	Project manager	1,3
State Agency Norway	Geotechnical engineer α**	1,3
State Agency Norway	Geotechnical engineer β**	1,3
Consultant Company A	Geotechnical engineer α**	1,3
Consultant Company A	Geotechnical engineer β**	1,3
Consultant Company B	Geotechnical engineer	1,3

Interview structure and design

The selected interview structure was of a semi-structured nature. Semi-structured interviews are characterized by a situation in which the interviewer prepares a set of questions but retains the flexibility to alter their order and ask follow-up questions if necessary (Bell et al., 2019). This approach is preferred for several reasons. Firstly, it is particularly suited when there is a clear objective regarding the questions that need to be addressed (Bell et al., 2019). Secondly, the flexible structure enables the interviewer to adapt to unexpected but relevant insights and topics that arise during the course of the interview.

The interview guide was tailored to each interviewee based on their industry knowledge and position, as well as the hypotheses that needed to be addressed in the current research stage. Rather than using the guide verbatim, it served as a foundation for formulating questions that were appropriate for the given context. This approach is recommended by Bell et al. (2019) to avoid a structured interview. In addition, Fitzpatrick (2013) suggests that when asking questions in an entrepreneurial setting, interviewers should not inquire whether a particular idea is good, but rather aim to identify the needs or challenges faced by the interviewee. This is intended to elicit true answers rather than merely agreeable ones. This strategy was employed in all of the interviews, such that, for example, questions about Propile were typically not raised until the end of the interview.

Whenever feasible, interviews were conducted in person, while online video meetings were utilized in situations where face-to-face interviews were not possible. Interviews were either recorded or transcribed using a digital live tool. This approach provides various benefits, including the ability to revisit the interviews to uncover insights that may have been missed during the initial interview process and *a more exhaustive examination of the participants' responses* (Bell et al., 2019). Whenever follow-up questions arose, they were either addressed via email or in a subsequent, abbreviated interview.

Interview sampling

The sampling approach utilized in this thesis can be classified as theoretical sampling, which falls under the category of purposive sampling. Theoretical sampling involves the collection of data that is guided by the results of previous data collection (Bell et al., 2019). A diagram illustrating the process of theoretical sampling can be found in Figure 3.2.

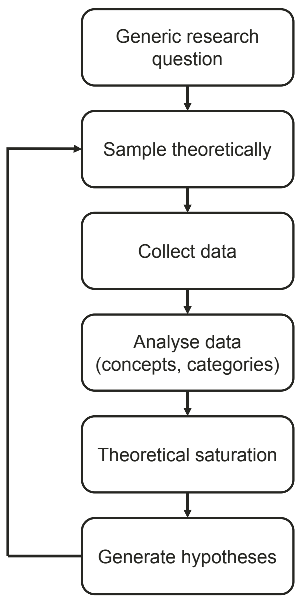

Figure 3.2: Theoretical sampling process (Bell et al., 2019).

The selection of theoretical sampling was considered appropriate for this study, as it aligned with the practical needs of Pålanalys and effectively addressed the research question. Additionally, snowball sampling was utilized in selected instances when interviewees had connections that could provide further insight.

3.4.2 Data analysis

Given the nature of the research project's qualitative approach and action research methodology, the data analysis process was executed primarily at the end of the project. Firstly, an evaluation of the result outcomes was conducted to assess the degree of applicability of existing theories within the specific research context. This examination aimed to identify potential challenges encountered when applying established theories to empirical findings. Secondly, the analysis delved deeper into the data, striving to identify patterns and themes that stood out as significant. The purpose was to identify any gaps in the existing theoretical framework, allowing for a more comprehensive understanding of unexplained outcomes or factors. This analysis process served as a means to extract valuable insights from the collected data.

3.5 Research quality

To ensure research quality, Guba and Lincoln (1994) suggests using the terminology credibility, transferability, dependability, and confirmability instead of validity, reliability, and objectivity in qualitative business research. Moreover, this thesis will follow Guba and Lincoln (1994) recommendations and how that is implemented will be described in the following subsections.

Credibility

The credibility criteria refer to if there are any discrepancies between the intended and expressed meanings of the interviewees (Bell et al., 2019). To ensure credibility in this project, the following actions have been taken. Firstly, the use of recorded and transcribed interviews enabled the researcher to review the material in case of any confusion. Secondly, the researcher posed clarifying and follow-up questions during and after the interviews, respectively, to address any ambiguities that might have arisen. Lastly, the use of triangulation, which involves obtaining information on the same topic from multiple sources (Bell et al., 2019), further strengthened the credibility of the study. It is also noteworthy that the interview questions are considered non-sensitive, which minimized the need for extensive interpretation of the responses.

Transferability

Transferability refers to the extent to which research results and insights can be generalized to other contexts (Bell et al., 2019). Since this study utilized a case study approach and an action research methodology, achieving transferability was not straightforward. This is because the research was conducted within a specific setting which poses challenges generalizing to a generic setting. To address this issue, the analysis of this report aims to discuss the result in a more general manner. Also, the thesis aims to provide a comprehensive description of the research setting, which enables the reader to gain a thorough understanding of the factors that influence the study's findings.

Dependability

Dependability pertains to the extent to which comprehensive documentation, encompassing notes, interview transcripts, and decision-based data, is meticulously maintained throughout the project (Bell et al., 2019). Additionally, as proposed by Bell et al. (2019), peers should adopt an audit-like role to oversee the process. However, this approach is not pragmatic for this study, given the constraints of insufficient resources and time. Nevertheless, complete records are being meticulously preserved throughout the project.

Confirmability

Confirmability criteria evaluate the extent to which the research is objective, recognizing that absolute neutrality is unattainable in business research (Bell et al., 2019). To minimize any potential influence on respondents, the interviews were conducted with non-leading questions. In the analysis phase of the project, the research has carefully considered not drawing overoptimistic inferences from data but instead utilizing multiple data sources to ensure the validity of the inferences. Additionally, a constant awareness of potential bias resulting from close involvement in the project was maintained throughout the research.

4

Overview of the Industry and Propile

This chapter will provide the reader with an essential overview of the contextual background within which this thesis was conducted. The purpose is to facilitate a deeper understanding of the subsequent chapters and their content. Moreover, the chapter briefly describes the deep foundation industry in Sweden, including the piling process, actors involved, piling installation, and Propile's features. The insights are based on interviews with industry actors.

4.1 The piling process

The process described below is a simplification of actual procedures, and it should be noted that the actual processes can be more complex and iterative depending on various factors. Additionally, the roles and responsibilities of stakeholders involved may vary depending on the project and organization.

When initiating a new building or infrastructure project, the client (which can be a real estate firm, public authority, or other entity) must investigate if the project requires piling. This is typically done by conducting a geological investigation, which involves drilling, hammering, and extraction of samples from a few points to determine the soil conditions. A geotechnical engineer, usually from an external consultancy firm, performs this process. Based on the results of the geological probe, a pile drawing is established by a designer, who may be either external or part of the main contractor's team. The next step is to select a foundation firm to execute the piling installation. The process typically involves a bidding process, with the lowest tender being awarded the contract, or a firm that is part of the same group as the main contractor being selected. In Sweden, turnkey contracts (fixed price) with adjustments for unforeseen events are common. Since piling work is typically conducted below ground, there are always adjustments to the final invoice.

Once the foundation firm is chosen, the main contractor prepares the soil by ensuring that it can bear the weight of the equipment. In parallel, the foundation firm prepares the necessary resources and materials. Surveyors then mark where to install the piles, after which the actual piling installation can begin. Depending on soil conditions and other machinery activities, the piles are installed accordingly by rig operators (skilled workers). In parallel with this process, tests on the installed piles are conducted to verify their bearing capacity, the position of piles is measured, and excavation is executed in the area.

After the piling installation is complete, the piles are cut to the correct length. Finally, the negotiation and confirmation of the invoice are handled. This process is illustrated in Figure 4.1.

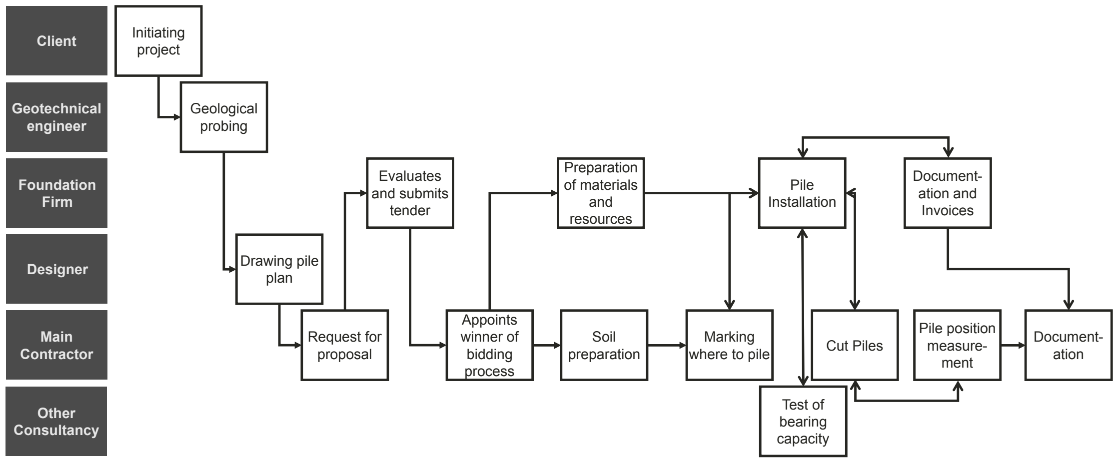

Figure 4.1: Overview of the piling process.

- Client: The end customer which can be a company, a public authority, or a private person.
- Geotechnical engineer: An engineer that specializes in the study and analysis of soil, rock, groundwater, and other geologic materials. Additionally, a geotechnical engineer may specialize in underground construction rather than focusing solely on soil properties.
- Foundation firm: Focuses on the work prior to the installment of a base plate. This involves piling installment as well as installment of sheet pile walls.
- Designer: In this context, the designer refers to the one with competencies in planning the pile plan.
- Main Contactor: Is the organization responsible for managing and executing a construction project, serving as the main point of contact with the client and hiring subcontractors, including foundation firms.
- Surveyor: Surveyors typically work as part of the main contractor's team, and are responsible for measuring and mapping the construction site, as well as planning and designing the installation of various components.

4.2 Piling installation

This section provides a brief overview of the different types of piles and how they are installed.

There are various types of piles and installation methods, with drilled and driven piles being the most common in Sweden. In some cases, piles may be cast as well. Furthermore, their installation depth depends on geological factors and the required carrying capacity. If the piles are installed down to rock, their bottom rests on a solid foundation, while friction piles rely on the friction between the pile and the surrounding soil along the length of the pile.

Pile elements are typically 3-13 meters in length and can be stacked on top of each other if needed. Steel and concrete are the most commonly used materials for piles, with steel piles being slimmer and more efficient to cut, making them ideal for complex geological conditions. However, they are three to four times more expensive than concrete piles and have a higher environmental impact. Concrete piles, on the other hand, are thicker and more commonly used in Sweden. The type of rig used for pile installation varies depending on the pile type. For example, the rig used to install drilled steel piles is different from that used to install driven concrete piles.

4.3 Propile's features

As previously mentioned, Propile offers a digital alternative for documenting pile installation, replacing traditional pen-and-paper methods. This is done with the use of an iPad in the operator's rig. In addition, Propile provides accessibility to information through iPhone devices and web browsers, with all data being stored in the cloud. The following features are available in Propile:

- Project Details: This feature captures essential project information such as project name, address, start date, and project manager.

- Pile Protocol: Propile includes a pile protocol module, accommodating both concrete and steel piles. It records details such as the installation date, pile type, and element length.

- Regulation: The Regulation feature allows for adjusting invoices based on outcomes that deviate from the initial plan.

- Printing: Users can export data in a standardized format, generating PDF documents for various purposes.

- Data Export: Propile facilitates the export of pile protocol data to Excel, enabling further analysis and integration with other systems.

- Statistics: The platform provides statistical insights, including metrics such as the number of meters of installed piles per day.

- Traceability: Propile can document traceability by scanning a unique barcode to each pile. This barcode contains information about the casting date and the production details of the pile.
- Pile Drawing in 2D and 3D: Propile offers a visualization tool for presenting pile drawings in both 2D and 3D formats. The tool includes various extensions, such as filters, which allow users to apply color coding based on the rig or the week of installation.

5

Result

The following chapter provides an overview of the project conducted in collaboration with Pålanalys. Firstly, an assessment of the current value creation is presented. Secondly, potential new features to be developed are explored. Thirdly, an analysis of new markets is conducted. Lastly, recommended next steps for Propile are proposed.

In terms of the chapter structure in relation to the actual project process, the value creation assessment was carried out simultaneously with new features discovery, with the exception of sections 5.2.4 and 5.2.5. Following this stage, a forum involving stakeholders of Propile, including Pålanalys employees and others, was convened to determine the most appropriate course of action for business development. This involved determining if the next focus should be on exploring new features or exploring new markets. Ultimately, it was determined that efforts should primarily concentrate on exploring new markets, while also pursuing some investigations into potential additional functionalities. Sections 5.2.4 and 5.2.5 detail the exploration of these alternative functionalities alongside the exploration of new markets. Figure 5.1 outlines the project process.

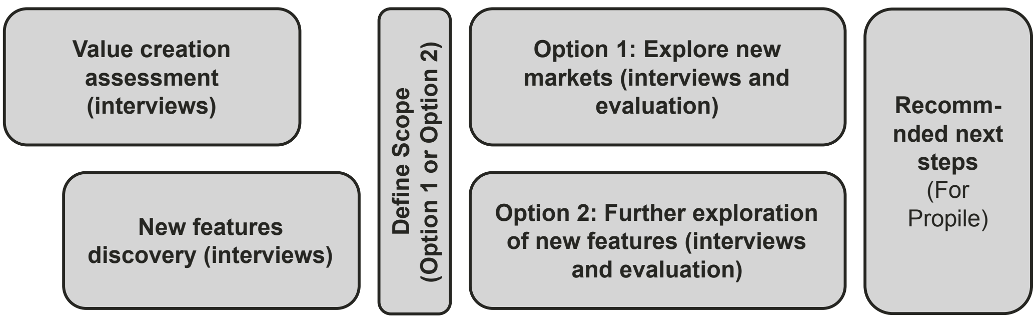

Figure 5.1: Planned project process.

The decision of exploring both Option 1 and Option 2 was motivated by two primary factors. Firstly, Pålanalys stakeholders expressed confidence in their ability to continue exploring the development of new functionalities (Option 2) beyond the scope of this project. Secondly, there was a perceived potential for greater growth and opportunities in venturing into new markets (Option 1). It was recognized that the current market had reached a saturation point, and therefore, introducing new features might not yield a significant increase in revenue since raising prices significantly to existing customers was assumed challenging. Nevertheless, there was also an interest in understanding how Propile is currently being utilized and how it can be further leveraged by other stakeholders such as geotechnical engineers within the ecosystem. The purpose is twofold: firstly, to facilitate in-depth exploration of the Swedish market, and secondly, to establish a robust knowledge foundation for future market expansions. As a result, some investigations were conducted within Option 2 as well.

5.1 Value creation assessment of Propile

The result presented in this section is derived through conducting interviews with existing customers to gather their insights, which were subsequently codified and categorized. Lastly, an assessment was made to estimate the monetary value creation. To categorize and organize value creation insights, the following four main categories were established: *Increased Control and Overview*, *Removal of manual steps*, *Improved internal communication*, and *Improved external communication*. These categories are presented as subsequent subsections, followed by an additional subsection that outlines the assumptions generated for the purpose of conducting the monetary estimation.

The estimated value creation amounts to approximately SEK 22,000 - 25,000 per month and rig, an overview is presented in Table 5.1. However, the estimates presented herein are subject to a high degree of uncertainty due to insufficient data. Moreover, it primarily relies on the hourly rates of supervisors and site managers (SEK 500) and the hourly operational costs associated with rig operations (SEK 3,000-4,500). A comprehensive exploration of these factors is provided in the subsequent subsections.

Table 5.1: Overview of the value creation assessment.

Identified Benefits	**Example**	**Estimated Value** [SEK per month & rig]
Improved control and overview	• Tracking the progress continuously by accessing real-time data • Allows to discover mistakes in an earlier phase	7,000-10,000
Removal of manual steps	• Removal of the step of translating handwritten notes into Excel	6,000
Improved internal communication	• Data standardization accessed in real time reduces information asymmetry	n/a
Improved external communication	• Facilitates externals to understand the ongoing construction project	9,000

Furthermore, this is primarily based on core users such as skilled workers, supervisors, and site managers. The evaluation of value creation is centered around their perspectives, comparing the use of Propile to a hypothetical scenario without it. Figure 5.2 provides a schematic aggregated overview of how Propile is used during this phase of the project.

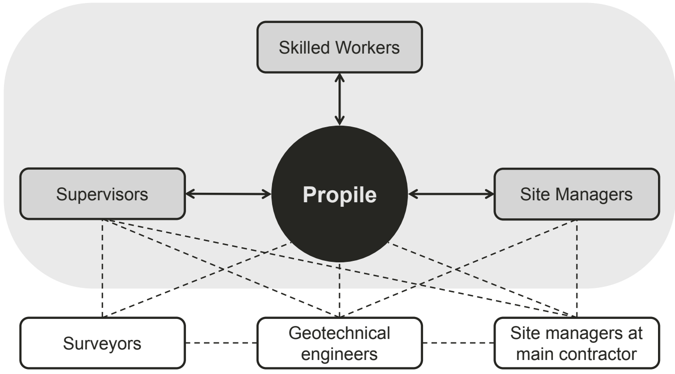

Figure 5.2: Communication patterns among selected users, illustrating the frequency of use through arrows, dotted lines, and the shaded grey area.

5.1.1 Increased control and overview

Propile creates value by reducing errors in day-to-day work. Real-time documentation within Propile allows for continuous progress tracking, enabling site managers, supervisors, and skilled workers to monitor each other's work and quickly correct any mistakes. Prior to Propile, documentation was typically transferred from skilled workers to supervisors at the end of the day or week. If the mistakes were only present in the documentation (not in real life), it still required extensive detective work to ensure accuracy on-site. For example, if a skilled worker installed pile #67 on a Tuesday morning, it would be difficult to recall that specific pile the following Monday, with potentially over 80 piles installed in between. Moreover, if the mistake were discovered in real-life work it can be very challenging and costly if the faulty pile was obstructed by other driven piles, which adds extra steps to the correction process.

Improved control is further realized through the ability to identify faulty pile plans before work begins, a capability not always available when reviewing only a PDF drawing and Excel list. Although such mistakes are rare, the costs associated with them can be significant.

Propile also creates value by providing better work oversight. This enables managers to continuously monitor progress instead of relying on phone calls or physical inspections of the construction site. The statistical functions within the software provide real-time data, allowing managers to track efficiency by day and identify any issues with the operation of particular rigs. These functions also enable the estimation of actual progress against expected time plans, providing an intuitive 3D visualization of completed work and future objectives instead of a list in an Excel sheet.

Lastly, skilled workers can use Propile's visualization and triangulation function to estimate the next order of new pile elements. Triangulation estimates the length of a given pile based on the closest adjacent installed piles. However, experienced workers choose not to use this function widely, as they claim to rely on their experience instead.

The interviewees were unable to provide precise data that could be utilized for accurate estimation of value creation within this category. Consequently, an approximate estimation was derived instead. Taking into account that improved error reduction and enhanced oversight would enable the rigs to operate for an additional two hours per month, while a supervisor would gain an extra two hours for other tasks, the estimated value creation amounts to SEK 7,000-10,000 per month. This corresponds to less than seven minutes per day. After consulting with stakeholders of Pålanalys, it was determined that this estimation is not likely an overestimation.

5.1.2 Removal of manual steps

This subsection outlines functions within Propile that automate manual processes, freeing up user time and allowing the user to allocate time to other activities.

Propile was initially designed to remove the manual steps of documenting the piling process by hand and then transferring the data into an Excel sheet or similar platform. This is now done digitally, eliminating the need for manual data entry. The Site Manager α in Foundation Company A and the Supervisor in Foundation Company B estimated that this save them approximately one hour per working day and per rig. In addition, Propile allows site managers to upload and review new projects quickly, estimated to save approximately four hours per project. However, since projects typically span several weeks or months, this time-saving function may not be as significant for the user.

Furthermore, the documentation that needs to be delivered from the foundation firm to the main contractor can be generated using Propile. The user can choose what details to include including invoicing adjustments and therefore generate a PDF with the push of a button. This is considered to only add value to a small extent since most of the firms already had similar tools using Excel templates.

For the purpose of estimating the value creation within this category, a decision was made to consider a time savings of 45 minutes per day instead of the 60 minutes reported by the interviewees. This 45-minute time savings translates to three hours per week (based on a four-day workweek) and 12 hours per month. With this assumption, Propile is projected to save SEK 6,000 per month.

5.1.3 Improved internal communication

Propile provides users with instant access to data in both visual and tabular formats, facilitating internal communication. This is exemplified by supervisors being able to use data to ask questions and follow up with rig operators. Construction updates can be updated directly in Propile instead of thru telephone or mail minimizing the risk of misunderstandings. In addition, site managers can utilize the visualization and statistic functions to create reports and materials for meetings with their superiors. This enables all parties to have the means to analyze and understand the current situation.

Although this is a feature that supervisors, site managers, and project managers claim to benefit from, an estimation of the value from an economic perspective has not been possible to estimate with the given data.

5.1.4 Improved external communication

The Propile platform provides an option for external users to access a project through a reader's view, thus enabling them to access real-time data without relying on mail or telephone communications. The visualization tool provides an intuitive overview that promotes transparency in the process and helps external users plan and adapt their next steps in the work progress. As noted by the supervisor at Foundation Company B, "Successful projects are often characterized by good dialogue and relationship between client and contractor".

Additionally, the visualization function in Propile can help justify foundation companies' invoices and avoid time-consuming invoice disputes by visually demonstrating how the initial geological investigation differs from the outcome, particularly when the client has limited knowledge of the foundation industry. This is a feature that both Site Manager α in Foundation Company A and Supervisor in Foundation Company B claimed have been very useful both during the project to ensure the client wants to proceed and also at the end of the project to justify the invoice.

It was concluded that estimating the value created by external stakeholder such as civil engineering firms was too uncertain to provide an accurate assessment. On the contrary, justification of invoices was considered feasible. While the interviewees were unable to provide an exact estimate of the revenue increase, a conservative calculation suggests that if their revenue increases by SEK 100,000 per year, this corresponds to value creation of SEK 9,000 per month (based on 11 months of annual work) per rig. Assuming that a rig generates at least SEK 30,000,000 in total revenue, the assumed amount of 100,000 only accounts for 0.3% of the overall revenue. As a result, it was concluded that this value is highly unlikely to be overestimated.

5.1.5 Establishing assumptions for value creation estimation

This subsection outlines the assumptions generated to create an estimation of Propile's value creation in monetary terms. It is based on data obtained from interviews, Pålanalys stakeholders, and annual reports. However, it should be noted that the available data may not be entirely exhaustive, resulting in estimations that carry a degree of uncertainty. With this in mind, the estimations have been intentionally conservative to prevent any potential overestimation of the benefits derived from the utilization of Propile.

As a foundational basis, two metrics were established. Firstly, the hourly rate for employing a supervisor or site manager within a foundation firm was considered, including social fees, insurance, and superannuation. Through discussions with Pålanalys stakeholders, a conservative estimate was determined to be approximately SEK 500 per hour. The second metric focused on the operational cost of running a rig for one hour. Moreover, the unit is adapted to correspond to Propile's current business model where customers pay per month and the number of active rigs. To increase reliability in the calculation, a triangulation method was employed, incorporating multiple calculations and insights derived from different approaches.

In the first approach, insights were gathered from stakeholders at Pålanalys and the Geoconstructor from Consultant Company C. Independently, they estimated the opportunity cost to be SEK 3,000 per hour. The second approach involved estimating the revenue per rig and hour based on an annual report. This report, combined with insights from the Project Manager in Foundation Company A, aimed to ascertain the proportion of revenue generated specifically from piling activities. The resulting fraction was then divided by the number of rigs and the number of working days, resulting in a daily revenue of SEK 150,000.

The third approach involved estimating the invoice amounts from two distinct projects and dividing these figures by the number of working days and rigs. This approach yielded revenue estimates ranging from SEK 125,000 to SEK 195,000. An average from the second and third approaches results in an hourly revenue of SEK 15,000, taking into consideration that skilled workers typically work Monday through Thursday for ten hours per day.

However, in the event of rig inoperability, the opportunity cost would decrease as the material is not consumed during that period. The fraction corresponding to the material was calculated by establishing a system of equations derived from an invoice containing various types of pile elements. By considering the volume of these pile elements, the material cost was estimated, resulting in a fraction ranging from 65% to 71%. Considering that the material cost accounts for 70%, the hourly revenue loss for a halted rig would amount to SEK 4,500 per hour. Utilizing these methodologies, the second measuring unit was determined to be estimated between SEK 3,000 and SEK 4,500 per hour.

5.2 New features discovery

This section presents suggestions for potential functions that could be incorporated into Propile in the future. Several methods were employed to identify these suggestions. First, the problem-centric approach described in Section 2.2.1 was utilized to identify problems that Propile could address. Second, a transformational mindset was applied to explore potential directions in an open-ended manner. Third, hypotheses were formulated whenever an idea emerged, ensuring that no assumptions were made about the validity of the ideas without testing them. Lastly, ecosystem mapping was occasionally employed to assess risks and illustrate the benefits of perceived suggestions. It should be noted that due to the time constraints of this project, extensive testing and validation of the suggestions have not been feasible, further details are provided in the following subsections.

5.2.1 Utilize existing databases as feedback for completed projects and knowledge in prospective projects

In the present day, companies that have employed Propile over an extended period have built up a database with old projects. This information is seldom revisited but is rather an untouched archive. Through brainstorming sessions with Propile stakeholders, this phenomenon was recognized as a potential opportunity to leverage. Subsequently, two hypotheses were formulated on the basis of insights obtained from interviewees as well as the brainstorming session.

The first hypothesis involves foundation firms using the Propile database as a means of comparing project outcomes with the initial project plans. This practice is currently used by some in the construction division of the firms on an individual basis in direct connection to the project. However, the estimating division rarely conducts such evaluations from an economic perspective. During interviews, it was noted that employees tend to shift their focus to the next tender once a submission is made, they described it as it was no time to focus on previously won tenders compared to the actual outcome. However, interviewees agreed that evaluating previous tenders should be done. To make such an evaluation today, they need to request the construction division to send over data from completed projects. Propile could provide a solution to this by serving as a tool with an adapted interface for the estimating division. Moreover, this would make it more feasible to obtain feedback from previous work by for example developing a summarizing page with statistics on project duration and pile usage. Apart from the time-saving benefit of such a function, it would also increase knowledge within the firm. Currently, the approach taken is akin to calculating math problems without verifying the answers. However, it was discovered that it is not always necessary to calculate with absolute accuracy. Rather, firms focus on increasing the probability of winning the contract and utilize gaps in the procurement structure to improve margins.

The second hypothesis posits that the Propile database can serve as a complementary resource for calculating and submitting tenders for projects that are geographically proximate to previous projects. Currently, this is only accomplished when a member of the estimating division is able to recall a nearby project, contact a colleague with access to relevant data, and obtain it. This results in valuable data from previous projects being underutilized. By projecting this data onto a map, an interface could be developed to determine if there are any applicable data from old projects that could be beneficial in both the calculation and planning phases of a new project. Old projects normally contain an address or global coordinates that potentially can make this interface feasible to implement from a development perspective.

Both hypotheses were tested with stakeholders within various firms. The first hypothesis was met with mixed feedback. For instance, the project manager at Foundation Company B expressed skepticism, by noting that the issue was beyond a software solution, but rather an organizational one. Nonetheless, he acknowledged the absence of a structured mechanism for collecting feedback. He also pointed out that not all projects were using Propile, thus rendering the data would be insufficient. Conversely, the business developer at Foundation Company B perceived the hypothesis as a beneficial concept. In addition, Foundation Company B intends to use Propile for all its projects in the future. Previously, it has been up to a site manager or supervisor to decide whether it is necessary to use the software. Therefore, the argument of not sufficient data will not be valid in the future (for this individual firm). The second hypothesis, on the other hand, generated solely positive feedback. All interviewees reacted favorably to this suggestion.

5.2.2 Extend towards the pile production plants

The data generated during the projects have been primarily utilized by skilled workers in foundation firms and their supervisors, as mentioned earlier. However, upon closer examination of the adjacent stakeholders in the value chain, pile production plants (hereafter plants) were identified as potential users who could utilize this data. It is noteworthy that these plants are part of the same group as the larger foundation firms. Currently, the ordering process at construction sites involves site managers placing an initial order for piles for the entire project during the planning phase, along with an estimation of how many pile elements will be needed per day. Skilled workers then make call-off orders from the initial order on a daily basis via telephone during the project. Depending on the geographical location of the site in comparison to the plant, an order takes between 1-2 days to be delivered.

From interviews, it was noted that this process has encountered difficulties in the past, but is improved today. The primary issue has been that skilled workers sometimes make orders too late, leading to the plant's inability to deliver the piles to the construction site on time. This can lead to significant costs for the foundation firms, as a lack of pile elements means that the rig cannot operate, and the rig bears the highest cost at a construction site.

Integrating Propile into the ordering process could potentially streamline operations for both plants and foundation firms. Propile would allow plants to monitor project progress and estimate pile needs in the near future. If project conditions change, Propile could indicate with its triangulation feature (estimates the length of a given pile based on the closest adjacent installed piles) that the average installed length has changed and the plant has the possibility to adjust its production accordingly. For skilled workers, the order process could be simplified by using Propile rather than relying on phone calls.

When presenting this suggestion to the Pile Factory Manager at Foundation Company A, the response was met with skepticism. The manager's primary concern was that the production of piles is mainly made towards stock, and the lead time for producing a pile typically takes between 4-7 days depending on the weather conditions (as the hardening process depends on temperature). Therefore, real-time insights about ongoing projects were not perceived to yield any benefits. However, other interviewees received the idea with more positivity claiming that production planning for a more balanced inventory could be improved by getting information earlier. Although, it is noteworthy that this suggestion was not fully presented to any participants due to being further developed later in the project.

5.2.3 Integrate delivery notes for pile elements and increase traceability of installed piles

Adjacent to the previous suggestion, the following suggestion is proposed. It stems from an idea made by Supervisor in Foundation Company B who expressed a desire to integrate delivery notes from pile production plants into Propile. Currently, delivery notes are provided in paper form and scanned manually to be stored and put in a binder to be delivered to the main contractor. Also, the local inventory of pile elements at construction sites is typically not documented. Instead, the proposal suggests sending the delivery note through Propile, which could be verified by scanning the arriving piles, as all piles are equipped with a barcode. This would imply that more of the administration work tasks are conducted in one system. In addition, as suggested by the interviewee Supervisor, a notification is sent when the transport is loaded to ensure the right piling elements are shipped. Consequently, two potential advantages could be realized: firstly, the automation of documentation processes, leading to time savings, and secondly, increased control over documentation and inventory management.

This concept was further explored as a potential solution to comprehensively document unique pile elements at installation, as opposed to solely documenting their type and length. Propile, already equipped with this functionality, allows for the scanning and documentation of pile elements using dedicated scanners, thereby enabling the traceability of every unique pile element. Although it is not always obligatory to document the location of each individual pile element, some companies have attempted to implement this process without success. Pålanalys stakeholders posit that the primary reason for this lack of success is the failure of skilled workers responsible for documentation to perceive the value of such activities. They do not recognize the significance of documenting these details. Consequently, foundation companies have thus far struggled to effect changes in work practices and incorporate this more comprehensive documentation approach. Conversely, the Business Developer at Foundation Company A believes that the scanners pose several issues. First, they are expensive to purchase, resulting in too few scanners being available at the construction site. Second, the scanners are prone to being temporarily lost. Another issue with the scanning function is the working environment, during harsh weather, there might be ice or snow on the piles resulting in problems scanning the barcode. Additionally, the barcode may become damaged during transportation.

Despite these challenges, several firms recognize the increasing need for complete documentation and traceability, especially as damage control if any issue occurs. For instance, at a construction site near Gothenburg, there were quality issues with some of the pile elements from a particular batch. Unfortunately, this issue was only detected after the piles had been installed and the site workers were unaware of the precise locations where these particular elements were installed. Consequently, an intricate and costly procedure had to be undertaken, involving dragging up multiple installed piles to identify the faulty ones.

Drawing from these insights, a proposal has been formulated to enhance the feasibility of documenting the entire process, including the traceability of each individual pile. The suggestion originates from the Business Developer, who proposes employing cell phones as a means of achieving traceability, as an alternative to scanners. Cell phones offer the capability to scan barcodes and QR codes, and utilize Near Field Communication (NFC) technology (Kjell.com, 2019). Leveraging the existing features of modern cell phones, it becomes possible to incorporate additional QR codes and NFC tags alongside the already existing barcodes. This approach ensures multiple scanning options are available, thereby mitigating potential issues arising from adverse weather conditions or barcode damage during transportation.

Figure 5.3 describes how these two combined suggestions can improve the workflow using Propile compared to the existing one. It is noteworthy to mention that these two suggestions are not dependent on each other, implying that one suggestion would work without the other and vice versa.

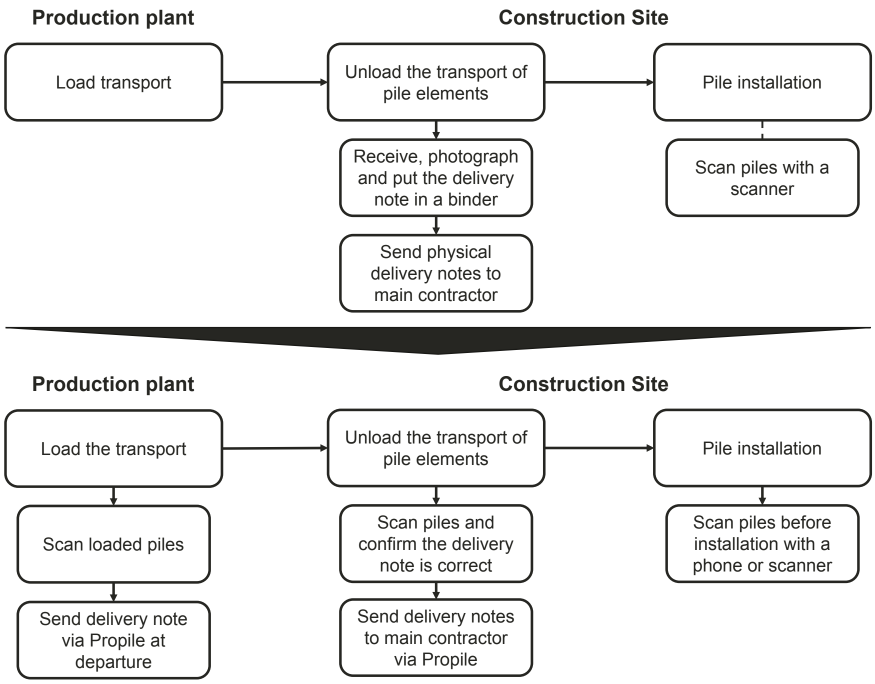

Figure 5.3: Comparison between the current work procedure and the proposed approach using Propile.

In terms of risk, the adoption chain risk is assumed as a more prominent concern compared to co-innovation risk. This distinction arises because the technology itself already exists, whereas the suggested work methodology necessitates the adoption of a new way of working by multiple actors. Furthermore, the adoption risk at the construction is considered low as work tasks will in general be more efficiently conducted. Conversely, the adoption risk in the production plant is likely to be higher due to multiple new steps. However, these suggestions were not subjected to further testing or presented to other stakeholders due to the prioritization of other initiatives.

5.2.4 Extension adapted for geotechnical engineers

The following suggestion aims to address several needs described by geotechnical engineers in Norway, described in Section 5.3.2. The suggestion is refined by stakeholders of Pålanalys.

Available data in Propile has been identified as something that geotechnical engineers can make immediate use of. However, incorporating the results from Pålanalys pile tests can further enhance the software's suitability for this profession. This includes integrating graphs generated from pile dynamics analysis, a specific type of test. These graphs will be organized within Propile, providing a more user-friendly interface compared to relying on receiving information in PDF format via email. The objective of this extension is to empower geotechnical engineers to adapt and optimize ongoing projects to a greater extent when encountering changed conditions that either permit or necessitate such adjustments. While the suggestions were initially to address the demands of the Norwegian market, the stakeholders of Pålanalys also explored the interest in this functionality within the Swedish market. During the project ends, the interface is being developed by programmers, however, it has not been extensively tested in line with the experimentation theory of using MVPs to evaluate the potential functionality.

5.2.5 Other potential applications of Propile beyond foundation firms

Other potential applications of Propile were explored through interviews conducted with stakeholders involved in construction projects who were not employed by foundation firms. These stakeholders included surveyors, site managers in civil engineering firms, and construction consultants.

The surveyors interviewed have used Propile to some extent via the reader's view. Surveyor in Civil Engineering Company B expressed the benefits of using Propile, stating, "If I work on two different projects, I can determine where to go and plan my day more efficiently". Additionally, Senior Surveyor in Civil Engineering Company A highlighted that "when delegating and dividing work tasks, it is much easier to plan using a live-updated drawing instead of trying to get a hold of a site manager or supervisor which often are very busy". Some initial exploration was conducted to assess the potential of utilizing Propile more extensively for these roles. This involved examining the feasibility of updating information within Propile instead of relying on email communication for tasks such as replacing piles or documenting pile position measurements in Propile instead of using separate Excel documents.

However, further investigation is necessary to determine the practical usefulness of these features for surveyors.

Similarly to surveyors, the Site Manager in Civil Engineering Company A recognized the value of having an overview of project progress for effective work task planning. He had recently started using Propile. The Construction Consultant in Consultant Company A also believed that accessing progress updates could be beneficial, although he had not yet personally tested the software. In summary, Propile appears to be useful for these stakeholders, but no additional functionalities that need to be implemented were identified.

An insight considered important from interviews with various stakeholders in the construction industry is the lack of awareness regarding the potential utility of Propile. Whether individuals outside of the foundation firms utilize the software depends on whether employees within the foundation firms have informed and granted access to relevant stakeholders. This can be attributed to either non-usage or recent adoption. The underlying reasons for this phenomenon have not been thoroughly investigated, but the suggested hypothesis is that individual employees within the foundation firms may not perceive the value in informing other stakeholders within their respective fields. It is worth noting that no drawbacks or disadvantages associated with sharing such data were identified during the interviews or discussions with Pålanalys stakeholders. To summarize, increasing the usage of Propile for other stakeholders may require more of an information or marketing effort rather than creating new functions or interfaces.

5.3 International market entry assessment

This section outlines the exploration of new markets outside the boundaries of Sweden and is structured as follows, the first subsection entails the market assessment of Europe undertaken to comprehend the market size and identify potential countries for introducing the product. The outcomes did not align with the intended objectives, leading to inconclusive findings in this area. The subsequent subsection centers on the exploration of the Norwegian market as an alternative option. Norway emerged as a viable choice due to pre-existing connections Pålanalys stakeholders had within the industry.

5.3.1 Market assessment of Europe

Four distinct approaches were employed to estimate the potential market size across various European countries. The first approach involved reaching out to the designated contact persons within an interest group of foundation contractors. A total of 18 individuals were contacted via email. Regrettably, only one respondent provided a response, albeit without furnishing the requested data.

The second approach encompassed conducting comprehensive online research to compile and summarize the annual revenue figures specific to each country. However, this method proved inadequate for two primary reasons. Firstly, numerous unlisted companies did not disclose their revenue. Secondly, relying solely on annual reports did not allow for precise determination of the proportion of a company's revenue derived from piling activities, as many of these organizations also operated in other business sectors.

The third approach involved considering the procurement of a market report. However, the associated cost of approximately SEK 10,000 was deemed too expensive, particularly considering the uncertainty surrounding the report's relevance to this project.

The fourth approach entailed the engagement of stakeholders from Pålanalys to establish contact with a pivotal stakeholder within the interest group of foundation contractors. Initially, this approach progressed to the planning stage, including identifying relevant interviewees and devising interview protocols. However, due to various circumstances beyond our control, this endeavor never materialized.

5.3.2 Exploration of the Norwegian industry

Two areas were identified for initial focus to assess the Norwegian industry in relation to Propile. Firstly, there was a determination to investigate the potential variances between the ecosystem of Norway and the Swedish industry. This decision was based on the existing knowledge of the stakeholders of Pålanalys, who anticipated differences in aspects such as contract forms and the chain of command. Secondly, an exploration was conducted to identify any challenges or requirements that could potentially be addressed through the implementation of Propile. These two initiatives are outlined in the subsequent subsections followed by an evaluation of the market potential in Norway. Moreover, the subsequent findings presented herein are derived from interviews conducted in Norway.

5.3.2.1 Ecosystem assessment

The Norwegian ecosystem exhibits notable distinctions when compared to its Swedish counterpart. First, turnkey contracts are uncommon in Norway as opposed to Sweden. Instead, general contracting is the prevailing practice. Under general contracts, contractors receive ongoing payments rather than a fixed price, resulting in a transfer of a greater share of project risks to the client. Consequently, contractors earn a fixed margin based on the work executed. Furthermore, foundation firms in Norway typically lack in-house geotechnical engineers during project execution. Instead, the expertise in geotechnical engineering is typically found within client organizations or is outsourced to consultancy firms. As a result, foundation firms have limited autonomy in determining the execution of the project, as project management is typically delegated to other entities within the ecosystem. In Figure 5.4, a schematic representation of the divergences in the ecosystem between Norway and Sweden is provided.

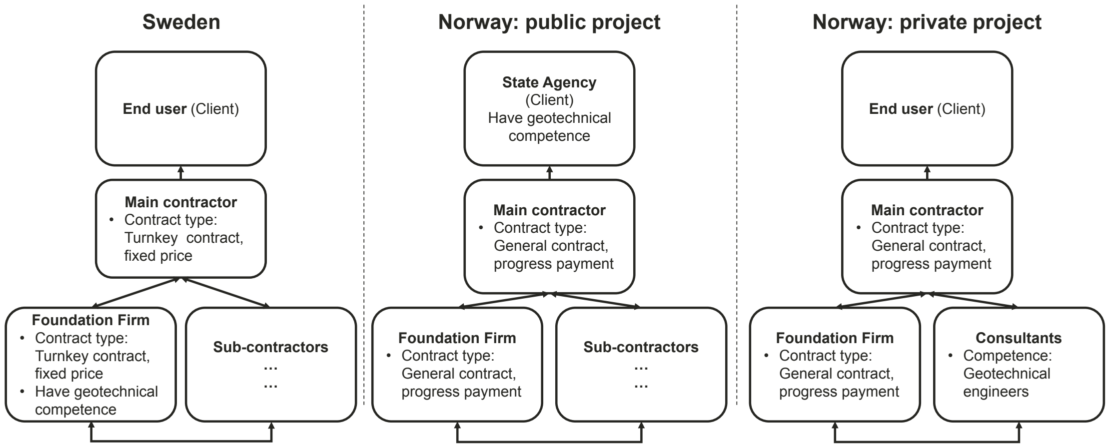

Figure 5.4: Comparison of key differences in ecosystems between projects in Norway and Sweden.

Additionally, payment structures also differ between the two countries. In Norway, foundation firms are compensated based on the number of executed drives, while in Sweden, payment is based on the number of installed meters. Moreover, the use of steel pile elements is more prevalent in Norway compared to the predominant use of concrete in Sweden. Despite these ecosystem disparities, the core activities performed in both countries remain fundamentally similar. The divergence lies primarily in the entities responsible for executing different activities.

5.3.2.2 Challenges and demands in the Norwegian industry

The stakeholders of Pålanalys have previously attempted to sell Propile to foundation firms in Norway, yet without success. However, limited attempts have been made to target other entities within the ecosystem. Consequently, the primary focus was towards engaging geotechnical engineers while foundation firms was considered a secondary focus. Through interviews conducted, several challenges and demands emerged that Propile has the potential to address:

- Real-time overview: Geotechnical engineers express a need for expedited data access. For instance, Geotechnical engineer α from the State Agency highlighted that “in some projects, it takes more than a day to install a pile, and then there is a reliance on skilled workers on-site to send a picture of the protocol which are documented with pen-and-paper”. Geotechnical engineer α from Consultant Company A emphasized that “data is supposed to be sent at the end of the day but, in some cases, it takes over a week to receive it”. Several other interviewees echoed similar sentiments, citing the need to chase after data too often.

- Standardized data: Each foundation firm adopts its own approach to data documentation, typically sending it as a PDF or a picture of a handwritten document. Geotechnical engineer α from the State Agency lamented that “this makes our work very cumbersome as they need to manually extract and organize the information to make use of it". Similarly, the Geotechnical engineer from Consultant Company B expressed "data is sent over in various forms, sometimes it can even be tricky to know which column represents what. When data is too unstructured, I do not put it in our BIM (Building Information Model) since it is more hassle than benefits of doing it".

- Complete data: Geotechnical engineer α from the State Agency emphasized that "despite existing standards outlining the required data elements, it is not uncommon for crucial information such as the date to be missing. This causes several issues and challenges in our work".

- Fewer systems and improved export capabilities: Geotechnical engineer α from the State Agency highlighted that "historically, we have been using different systems in relation to the foundation firms and this has caused several challenges where it has not been possible to export data smoothly". The Geotechnical engineer from Consultant Company B echoed this sentiment, emphasizing the need for seamless data transfer between systems. Additionally, Geotechnical engineer α from the State Agency expressed a desire to integrate the pile inspection results, which refers to measurements, for instance, Pålanalys' conducts.

In terms of foundation firms, it was found that some already possess their own digital documentation tool, but its accessibility is limited to internal employees of the respective firm. This software solely serves the purpose of digital documentation, in other words, no additional functionality. It was determined that for these firms, the adoption of Propile is unlikely to have a significant impact on their operations due to the dynamics of the ecosystem. On the other hand, firms that do not utilize such systems may benefit from adapting a digital tool like Propile. This advantage may be even more pronounced compared to Swedish firms, considering the insight that Norwegian documentation tends to be more comprehensive, requiring more detailed information to be recorded.

5.3.2.3 Evaluation of the market potential in Norway

The possibility of entering the Norwegian market with Propile appears to be quite promising. Moreover, this evaluation is divided into two categories: the potential inclusion of Propile in public projects and its integration into private projects.

Public projects: Geotechnical engineers from the state agency have demonstrated significant interest in Propile and have expressed their willingness to utilize the software for an upcoming big project, recognizing its potential to streamline the handling of extensive data requirements. To progress further, group meetings have been held with more than 15 individuals from the state agency. During these meetings, Pålanalys stakeholders have provided detailed technical demonstrations of the software, showcasing its functionalities and illustrating how it can be effectively employed. Additionally, a demonstration of a newly developed extension that integrates the pile inspection conducted by Pålanalys has been presented. This extension is described more detailed in Section 5.2.4.

Furthermore, to enhance the likelihood of a successful introduction when the project starts (in the event of them choosing to use Propile), it was suggested to initiate a pilot project as an initial testing phase for the software. This pilot project would serve to evaluate the software's functionality, train relevant stakeholders, and make any necessary adjustments. Although there are currently no viable projects available for conducting such tests, old data has been forwarded to Pålanalys for manual testing, simulating the integration of such data into Propile.

The primary potential barrier identified relates to the acceptance and adoption of the software by foundation firms. Geotechnical engineer α from the State Agency emphasized the importance of user-friendliness, stressing that the software should be easy to use without unnecessary complexities and that "the iPad cannot lie in the knee of the rig operator". While this aspect has not been thoroughly explored due to the absence of a selected company for the upcoming project, it is concluded that this barrier should be surmountable, given Propile's historical track record of overcoming similar challenges through adaptability and user-centered design.

Private projects: Reaching private actors, on the other hand, appears to be a more complex challenge. While several interviewees expressed positive attitudes towards using software for real-time data access, their willingness to pay for such a service was less enthusiastic. From interviews, it was made clear that geotechnical engineers (from private firms) and main contractors had no interest in paying. For instance, the Contract manager in the Civil Engineering Company expressed that "it must be the firm that generates the data that also pays for the software". A proposed hypothesis suggests that foundation firms would be responsible for documenting the data which would facilitate the work of primarily geotechnical engineers and potentially main contractors resulting in cost streamlining. However, the value capture of such a process would primarily benefit the end user, namely the client. This hypothesis is based on the premise that consultancy firms may experience improved efficiency but may not see a substantial increase in their revenues by using Propile. This dynamic is illustrated in Figure 5.5.

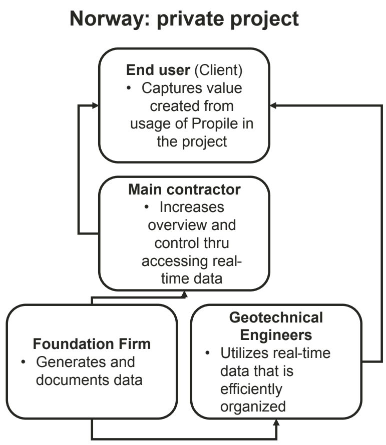

Figure 5.5: Hypothesis: Value capture process in Norway with Propile.

This challenge was discussed with a CxO from Civil Engineering Company C, who suggested that the ongoing collaboration with the state agency could serve as a catalyst for private firms. From his experience, if a certain standard is set by the state agency, many firms would likely adopt it. Or as he expressed it, “if they say jump, everyone jumps since they are one of the biggest clients”. According to him, this pattern is observed both in Sweden and Norway, regardless of project type. This perspective was also shared by stakeholders of Pålanalys.

Furthermore, considering the potential cost optimization offered by Propile, one can assume that this optimization may involve the elimination of manual steps for geotechnical engineers. Consequently, consultancy firms might have to allocate less time to these tasks, potentially resulting in reduced invoicing. Interestingly, the interviewees did not express concerns regarding this aspect, nor did it become apparent through implicit communication. Rather, they viewed it as an opportunity for the industry to progress and embrace modernization. Nonetheless, it would be prudent to monitor this aspect in a prospective future scenario, as it could potentially pose a barrier to adoption.

In parallel, an alternative approach was devised for the project. It involved repositioning the value proposition of Propile towards foundation firms. Rather than solely focusing on internal value creation for these firms, the software would be positioned as a competitive advantage during tender submissions, increasing the likelihood of winning more projects. It would be portrayed as a tool that benefits the overall project. Furthermore, exploring the possibility of including the cost of the software as part of the final contract invoice to the client was considered. This approach assumes that the client, as the primary beneficiary of foundation firms and other subcontractors using the service, would bear the cost. However, this concept was not tested within the timeframe of this project.

5.4 Recommended next steps at the project’s end

This section presents recommendations for Pålanalys stakeholders at the conclusion of the project. Moreover, the section is divided into three parts: the suggested software positioning, the approach toward foreign markets, and resource allocation by altering the course to an entrepreneurial methodology.

5.4.1 From digital tool to a platform perspective

Undoubtedly, there are numerous stakeholders beyond the rig operator, supervisor, and site manager who can benefit from accessing Propile’s data. Instead of solely focusing on the rig operator and their immediate supervisors, Propile should be viewed as a platform that fosters efficient collaboration among stakeholders across different organizations. While external parties already have access to the data, there is potential to further leverage this capability. Some stakeholders, like geotechnical engineers, may require adapted interfaces to generate greater demand for Propile. Others, such as site managers in the main contractor firm may find that the current version already provides all the necessary information.

There are several potential benefits associated with positioning Propile as a platform. First, having more users can generate additional revenue streams if valuable functions are identified as stakeholders beyond the current customer segment will be more inclined to pay for their usage. However, charging these stakeholders should be approached carefully, as the strength of the platform depends on the number of users since one user's input can benefit others in certain scenarios. Second, if stakeholders such as the main contractor become accustomed to using Propile and find it beneficial, this can lead to increased adoption among foundation firms. Assuming the main contractor or client mandates the use of a digital platform, more foundation firms will be encouraged to utilize it. Lastly, as the number of users grows and they become accustomed to the software, it has the potential to create a lock-in effect where Propile becomes an industry standard that everyone is familiar with. Figure 5.6 illustrates the potential evolution of this platform compared to the current situation.

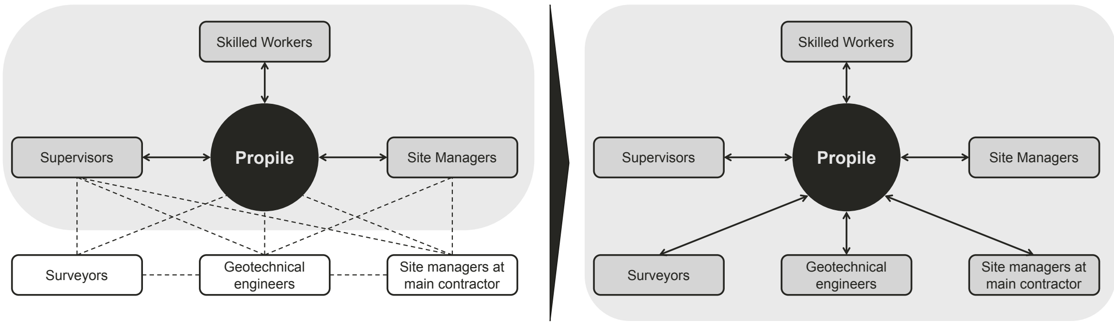

Figure 5.6: Repositioning Propile from a tool to a platform.

To encourage wider adoption of Propile among other stakeholders, it is recommended to initiate marketing or educational efforts. Currently, Propile's customers act as gatekeepers for expanding its usage, and thus, efforts to educate others can facilitate broader adoption. This could involve reaching out to main contractors and informing them about the possibilities and best practices from other projects. Additionally, creating informational materials that can be shared with relevant stakeholders can be effective in promoting Propile's usage.

In regards to the proposed new functions, such as creating interfaces for the estimation department in the foundation firms and integrating delivery notes into Propile, it is recommended to conduct further tests, discussions, and pilots to determine which functions have the potential of *product-market-fit*. This is to ensure that resources are allocated to functions that are more likely to create value when implemented. If successful in implementing new functions, such as the development of an interface tailored for geotechnical engineers, the platform positioning of Propile can be realized to a bigger extent.

5.4.2 Market penetration in Norway and other markets

Based on the insights gained from interviews and input from Pålanalys' stakeholders, the focus is recommended to be on using the initial lead with the state agency to establish a stable position by setting an industry standard. A successful collaboration with the state agency can generate interest and demand from the private sector. In regards to the private sector, it is recommended to further investigate and test the positioning of Propile as a competitive advantage, but the primary emphasis should be on effectively managing the project with the state agency first.

Furthermore, in regard to reaching other markets, further assessment is required to identify target countries. Factors to consider include market size, similarity in piling techniques, and a willingness to embrace digital workflows. In addition, Propile stakeholders should ensure that there are no existing internal systems within firms that diminish the appeal of adopting Propile. Furthermore, recognizing that state agencies often set industry standards in both Sweden and Norway, a similar approach could be considered when approaching other new markets.

5.4.3 Resource optimization by adapting to entrepreneurial work methodologies

By taking a bird's eye view of the result, many different pathways have been explored, which resulted in no specific pathway have been thoroughly explored. Several new functionalities as well as new markets have been explored. Arguably, it is worth considering if the project would be better off if discarding some pathways earlier in order to focus more thoroughly on a few specific initiatives. On the other hand, discarding pathways too early may result in missing out on significant innovation. Moving forward, it is necessary to narrow down the alternatives, to avoid the risk of having several half-finished initiatives. The point here is that due to limited resources, it is important to recognize that multiple initiatives cannot be pursued simultaneously, even if they appear promising.

To optimize resource allocation effectively, it is advisable to employ experimentation theory as advocated by Blank and Dorf (2012); Ries (2011). This approach involves utilizing methods such as creating MVPs, which allows for trying out specific functions before fully developing a finished product. By validating ideas through testing, Pålanalys can avoid investing resources in features that do not have proper user utility. Implementing this methodology would necessitate a significant departure from the current procedure, posing a considerable challenge. However, according to existing literature, it is undoubtedly beneficial in the long term.

To address any potential uneasiness associated with presenting unfinished products (which MVPs imply) to customers, it is advisable to follow the recommendations outlined below. First, acknowledge the purpose behind presenting MVPs, which is to leverage the superior product development knowledge held by Pålanalys stakeholders in conjunction with the interviewee's expert knowledge in a specific area. In addition, acknowledge that this approach enables the interviewee to actively contribute to the product's development and eventual outcome. This recommendation aligns with Sarasvathy et al. (2020) who argue that expert entrepreneurs *acknowledging what they don't know, they are able to bring in experts who feel ownership for more fully shaping outcomes vis-à-vis their expertise.* This approach was used in the interviews and was arguably working as intended to create trust and interest by acknowledging the purpose of the interview. An illustrative example of how this approach was employed can be found in Appendix A. Secondly, it is recommended to introduce MVPs initially to stakeholders with whom strong relationships have already been established. This approach allows Pålanalys stakeholders to mitigate any perceived risks associated with affecting first impressions.

6

Analysis and Discussion

This chapter presents the analysis and discussion of the findings obtained in relation to the aim of creating guiding principles for smaller firms. First, the efficacy of the employed theories will be evaluated to gauge their practical applicability. Second, attention will be given to additional considerations that may complement the selected theories.

6.1 Effects of conducting a value creation assessment

In regard to the theory applied in this thesis, value creation assessment before exploring business innovation is actually not explicitly considered. For instance, the customer orientation theory, as described by Lervik Olsen et al. (2014), underscores the significance of collecting structured customer feedback to inform strategic decision-making. However, it does not explicitly recommend collecting data to assess the value creation, nor is it arguably regarded as an integral part of start-up theories such as the work by Blank and Dorf (2012).

In terms of start-up theories, including the works of Blank and Dorf (2012) and Ries (2011), do not explicitly mention the need to conduct a value creation assessment. This omission may stem from the description of start-ups as entities that *has no customers and minimal customer knowledge*, implying that they are not specifically tailored to smaller, already established firms. On the contrary, when applying an *experimentation* methodology, such as employing the business model canvas in a small firm, understanding the current business and its value proposition is essential for validating its accuracy.

Likewise, the transformation theory proposed by Sarasvathy (2008) does not explicitly incorporate this step. However, it should be noted that Sarasvathy's (2008) work may not be as practically oriented as the experimentation theory. In addition, one could argue that awareness of how the firm delivers value to customers is necessary to understand the *set of giving means* which Sarasvathy's (2008) model is based on.

While conducting a value creation assessment is not explicitly recommended, several benefits have emerged from undertaking this step. These benefits can be categorized into two perspectives: the firm's viewpoint and the perspective of an external actor's participation in business innovation.

6.1.1 Firms should ensure to have a profound understanding of the current situation

From the firm's perspective, this initiative yielded several valuable outcomes. Firstly, the insights obtained provided all stakeholders involved in the project with a unified understanding of how Propile is currently utilized and the value it generates. Secondly, this exploration clarified the value proposition, which can be utilized in future sales efforts and serve as an indicator for pricing. Thirdly, it surfaced potential gaps in the current offering. Lastly, and perhaps most importantly, it enables the firm to determine the next steps. Regardless of adopting a *transformation* or *experimental* perspective, knowing one's current position is essential. Without knowing where you are, it becomes impossible to determine if the next step is upward, downward, leftward, or rightward. This leads to the following proposition:

Proposition 1: *Firms need to ensure they have a profound understanding of how they create value before exploring business innovation. - Why do customers actually buy our product/service?*

6.1.2 The importance of establishing a deeper knowledge of the industry as an external

From the perspective of an external actor participating in a project within an unfamiliar industry, it can be argued that possessing not only aggregated knowledge but also deep, specific knowledge is crucial. The establishment of such knowledge leads to the following outcomes. Firstly, it enhances communication among project stakeholders, arguably, information asymmetry was reduced as the project proceeded. Secondly, it enables more profound follow-up questioning during interviews, for instance, the interviews with geotechnical engineers in Norway would be more challenging to conduct without prior knowledge about the industry. Thirdly, and potentially most important, in order to effectively utilize interview data for the development of new features, particularly within a complex ecosystem, a deeper understanding of the industry is imperative. Interestingly, Holgersson et al. (2022) make a similar argument, stating that to build a successful ecosystem requires that *managers must understand their technical systems at the level of components and linkages. Broad-brush descriptions of technologies as "general purpose," "radical," "incremental," and "disruptive" are insufficient.* This leads to the next proposition:

Proposition 2: *External actors working in a new setting must establish a general as well as deep knowledge about the industry to be able to develop the business model.*

6.2 New features discovery - leveraging the aggregated perspective

The applied theories, such as *getting out of the building*, searching for problems (Blank and Dorf, 2012), and adopting a transformation perspective (Sarasvathy, 2008), have proven to be effective methods for exploring new opportunities. This is evidenced by the identification of several potential features that could enhance the value proposition. Positive responses were received for certain suggested features, as described in Section 5.2.1, which implied creating a structured database with a geographical interface. Additionally, Section 5.2.4 highlights an interface adapted to geotechnical engineers, which also garnered favorable feedback. However, there were suggestions that faced more skepticism. For example, in Section 5.2.2, the proposal to adapt Propile to production plants encountered a higher degree of skepticism.

Since none of the suggested features have undergone extensive testing within the timeframe of this project, it is not possible to validate or dismiss any of them conclusively. Nonetheless, the identification of these features serves as evidence of the utility and effectiveness of the applied theories in uncovering new opportunities.

Furthermore, an interesting insight that emerged from the interviews is that the problems (and solutions) described by the interviewees tended to only involve smaller changes or replacements. These could manifest as requests for missing functions, suggestions for new digital functions to replace physical ones, or inflexible user experience. One hypothetical explanation for this pattern is that the interviewees often had a deep but narrow perspective, possessing extensive knowledge within their own sphere but lacking exhaustive insights in other areas. Consequently, the described problems and solutions also exhibit a narrow focus. Furthermore, interviewees who already use Propile may have been biased or anchored to existing functions, limiting their perspective on what could be achieved.

For example, the suggestions of utilizing existing databases as feedback in Section 5.2.1, adapting Propile for production plants in Section 5.2.2, and the mentioned extensions in Sections 5.2.4 and 5.2.5 were all derived from either this project or Propile stakeholders by combining several different insights. The suggestion of integrating delivery notes and increasing traceability was the only one mentioned by interviewees, beyond the smaller suggestions in Appendix B. One can argue that this implies a lack of sufficient listening to the customers by the project stakeholders. However, an alternative perspective suggests that aggregating various insights and leveraging individual inspiration can lead to more significant impacts. Moreover, Christensen and Bower (1996) argues that closely adhering to customers' stated wants can hinder the pursuit of radical innovations. Customers may not know what they want in the future because they are not aware of the possibilities. Hence, it is arguably important to listen attentively to relevant stakeholders while also leveraging personal ideas and inspiration.

When operating within an ecosystem aiming to develop ideas that affect multiple entities or users, or alter the ecosystem's structure, the narrow insights can still serve as building blocks (as exemplified above). Insights can be seen as puzzle pieces that entrepreneurs must assemble to form a more comprehensive idea. Moreover, this leads to the next proposition:

Proposition 3: *Innovators hold the key to perceiving the broader vision by combining insights as puzzle pieces.*

To achieve this, the ecosystem mapping described by Adner (2013) is suggested to serve as a useful tool. By mapping the current setup and placing potential problems or insights adjacent to different activities, one can identify existing issues. Building upon this map, one can explore solutions by modifying the flowchart itself or by devising a product that addresses multiple problems simultaneously.

6.3 Insights from assessing new markets

The exploration of new markets resulted in mixed outcomes. While it did not achieve the initial goal of mapping and gaining a comprehensive understanding of the European market, the interviews conducted with stakeholders in Norway arguably provided valuable insights for future work. This further underscores the significance of adopting the *get out of the building* approach (Blank and Dorf, 2012). Moreover, the problem-centric approach described by (Blank and Dorf, 2012) proved valuable to understand the needs of the stakeholders compared to demonstrating Propile directly which could imply overlooking challenges they encounter.

Furthermore, the application of ecosystem mapping, based on Adner (2013) framework, proved to be valuable. Firstly, it allowed structuring insights, providing a comprehensive overview. Secondly, this overview facilitated internal discussions with Pålanalys' stakeholders and served as a foundation for conducting further interviews with for instance the CxO of the Civil Engineering Company C. Lastly, it served as a visual representation of proposed approaches to engage the private sector.

Given the alignment of the aforementioned discussions with existing theoretical knowledge, no proposition will be formulated at this stage.

6.4 Emerging implications from the project's end

The results presented in Sections 5.4.1 and 5.4.2 primarily consist of strategic recommendations for future work, thus providing limited analysis and discussion in relation to the aim. However, the recommended actions outlined in Section 5.4.3 pertain more to the work structure to achieve the strategic recommendations by emphasizing the significance of prioritization and proposing entrepreneurial methods and are therefore relevant to include in this section.

Regarding prioritization, it is difficult to definitively determine if alternative approaches would have yielded better outcomes in this project. Nonetheless, at some point, it becomes necessary to narrow down various alternatives to thoroughly explore selected initiatives, especially if the firm has limited resources. Otherwise, there is a risk of not fulfilling any initiatives. In this context, the theory is relatively clear. Eisenmann et al. (2012) describe how *an entrepreneur should give priority to tests that can eliminate considerable risk at low cost.* However, translating this theory into practice can be challenging. Obstacles may manifest as numerous intriguing paths that are difficult to deprioritize, emotional attachment to specific ideas, and limited resources, which make it impractical to test all ideas, resulting in some remaining partially explored. This leads to the following proposition:

Proposition 4: *Firms with limited resources must acknowledge the challenge of prioritization in selecting initiatives; otherwise, they risk leaving all undertakings unfinished.*

Furthermore, beyond prioritization, fully transitioning to an entrepreneurial work methodology and embracing significant changes in work practices based on this project is not a straightforward endeavor. Apart from the inherent difficulty of change itself (Sirkin et al., 2005), there may be concerns about the perceived risk of presenting unfinished products, potentially undermining the professional image. Additionally, established firms with existing revenue streams and products may feel they have more to lose compared to brand-new startups without customers or revenue. Suggestions have been presented in Section 5.4.3 to address these challenges, such as framing interactions to acknowledge the need for specific expertise while maintaining confidence in the firm's own expertise. Another mentioned suggestion is to initiate discussions with stakeholders who already have a strong relationship with the firm. While these suggestions are supported by experience from conducted interviews in this project and theory by Sarasvathy et al. (2020), it is essential for external actors to recognize the challenges associated with implementing such methods. This leads to the final proposition:

Proposition 5: *External actors must acknowledge that introducing entrepreneurial methods to firms may involve addressing and mitigating concerns to successfully embrace the new practices.*

7
Conclusion

The aim of this thesis was to establish guiding principles for smaller firms that strive to develop their business within a complex ecosystem, including scenarios involving the participation of external actors without prior industry knowledge. To achieve this, a project was undertaken in collaboration with Pålanalys AB and their software service Propile. The project encompassed an assessment of the current value creation process, exploration of new features, and investigation into potential market expansions.

Existing theories, such as ecosystem mapping and startup methodologies, were applied to the project. This served as a foundation for analysis to evaluate the applicability of these methods and identify any potential enhancements or complementary approaches. The findings highlight that existing methods and theories can function well in the context of smaller firms. While no existing theories were replaced or questioned, a set of five guiding principles adapted for smaller firms were formulated to complement the existing knowledge.

First, conducting a value-creation assessment, which is not explicitly recommended by startup theory, proved beneficial to the firm. It facilitated knowledge alignment, clarified the value proposition, and identified gaps in the current offering.

Proposition 1: *Firms need to ensure they have a profound understanding of how they create value before exploring business innovation. - Why do customers actually buy our product/service?*

Second, this initial assessment also demonstrated the advantages of acquiring deeper industry knowledge for external actors. This knowledge reduced information asymmetry, enhanced interview effectiveness in the given setting, and improved the ability to identify new features.

Proposition 2: *External actors working in a new setting must establish a general as well as deep knowledge about the industry to be able to develop the business model.*

Third, the process of feature discovery revealed that innovators can leverage their aggregated perspective by combining narrow customer insights as building blocks to create innovations that potentially gain several entities. This concept is captured in the following proposition:

Proposition 3: *Innovators hold the key to perceiving the broader vision by combining insights as puzzle pieces.*

Fourth, by actively participating in the project over a certain period, it was recognized that while the theoretical principles remained clear, translating them into practical reality and changing established ways of working posed challenges. This leads to the following two propositions:

Proposition 4: *Firms with limited resources must acknowledge the challenge of prioritization in selecting initiatives; otherwise, they risk leaving all undertakings unfinished.*

Proposition 5: *External actors must acknowledge that introducing entrepreneurial methods to firms may involve addressing and mitigating concerns to successfully embrace the new practices.*

As this thesis was conducted similarly to a case study format, it is important to note that the proposed guiding principles are derived from a single case. Further research involving multiple cases would enhance the generalizability and robustness of the identified principles.

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A

Appendix - Interview Guide

The following interview guide serves as an illustrative example of the interview guides utilized. While certain questions were asked in all interviews, others were tailored to the position and expertise of the interviewee.

Introduction

This thesis is being conducted in collaboration with Pålanalys and their service, Propile. The practical project aims to explore the current value proposition of Propile, potential avenues for its further development, and the feasibility of expanding into markets beyond Sweden. To gain valuable insights, it is crucial to gather firsthand perspectives from professionals actively engaged in the construction industry. Therefore, I have sought your expertise to gain a comprehensive understanding of the industry's daily operations.

Moreover, please note that all information shared during this interview will be treated with confidentiality. Your name and the company you represent will be anonymized. Additionally, I kindly request your permission to record the interview, as it will allow me to be fully present during our discussion and review the responses more accurately. Rest assured that these recordings will not be shared with any third parties and will be deleted upon the project's completion.

Questions

Background

- What is your current position, including your roles and responsibilities?
- What prior roles have you held that are relevant to your current position?
- Walk me through a typical day in your role. What tasks and activities are typically involved?

The role in the ecosystem

- Can you describe the activities that precede and follow your work tasks? Which actors are involved in these processes?
- With whom do you typically collaborate among other actors/entities?

Information Sharing and Usage

- How does the flow of information occur within your work environment? What methods are employed for sending and receiving information, and what file types are commonly utilized?
- Are there any specific types of information that would greatly benefit your work or alternative formats that would be preferable?
- How are you using Propile today?
- Are there any additional work tasks that you wish could be performed with Propile?

Other

- Are there any other aspects or functionalities that you find to be less optimal or pose challenges?
- If you had the opportunity to make any desired changes or improvements, what specific alterations would you envision?
- Anything else you would like to add?
- Are there any other individuals you recommend I speak to in order to gain further perspectives and insights?

B

Appendix - Suggested developments of Propile

The following list consists of minor improvements for Propile that were suggested by interviewees, which were considered to focus solely on making small enhancements.

Suggestions from supervisors and site managers

- When entering an inclined pile, it can be useful to see the visualization directly instead of going back and forth in the program.
- Possibility to change the name of the pile.
- Possibility to “merge” two piles into one.
- Possibility to add information to a whole column of piles at the same time.
- Export the statistics as raw data.
- Possibility to remove a pile from the invoice while keeping it in the drawing.
- Export figures from the visualization tool.
- Some kind of undo button functioning similarly to Excel (CTRL-Z).
- Make it possible to start a new project in Propile without having a project number.
- Being able to make a cross-section of the visualization instead of only rotating “around it”.
- Framed walls function could be improved similar to the piling function.

Suggestions from skilled workers

- Ease of use when documenting on the front page. One has to go out of the front page to document the last details of the installation (stoppslagning).

- Triangulation disappears after pressing down on the dialog box. It would have been good to keep the information among “other information”.
- Simplify documenting e.g. clay plug (e.g. just press a + or -).
- Get machine data into Propile (from the rigs).

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